

**CORRECTIVE MEASURES STUDY REPORT**

**CHLOROFORM RELEASE AREA AT  
FORMER BUILDING 028J**

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## LIST OF ACRONYMS

bgs	below ground surface
BAAQMD	Bay Area Air Quality Management District
CalEPA	California Environmental Protection Agency
CAO	Corrective Action Objective
CCR	Current Conditions Report
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cm/s	centimeters per second
CMS	Corrective Measures Study
COPC	Chemical of Potential Concern
CPT	Cone Penetrometer Test
DBP	disinfection by-products
DCA	1,1-Dichloroethane
DCE	1,1-Dichloroethene
DHS	Department of Health Services
DJPA	David J. Powers & Associates
DRE	Drewelow Remediation Equipment, Inc
DTSC	Department of Toxic Substances Control
EIR	Environmental Impact Report
ESA	Environmental Site Assessment
FEMA	Federal Emergency Management Agency
GAC	granular activated carbon
GPA	General Plan Amendment
Gpm	gallons per minute
GST	Global Storage Technologies
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HLA	Harding Lawson Associates
IBM	International Business Machines
kg	kilogram
kV	kilovolt
LQG	large quantity generator
MCL	maximum contaminant level
mph	miles per hour
µg	microgram

## **LIST OF ACRONYMS (Continued)**

mg	milligram
MNA	monitored natural attenuation
msl	mean sea level
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
OMMP	Operations, Monitoring, and Manitenance Plan
PCE	Tetrachloroethene
PD	Planned Development
PG&E	Pacific Gas & Electric
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RBTC	Risk Based Target Concentration
RCRA	Resource Conservation and Recovery Act
R&D	Research and Development
RG	Remedial Goal
RWQCB-SF	Regional Water Quality Control Board – San Francisco Bay Region
SI/SP	Soil Inspection and Sampling Plan
SMP	Soil Management Plan
STL	Severn Trent Laboratory
SVE	Soil Vapor Extraction
TCA	1,1,1-Trichloroethane
TCE	Trichloroethene
TEG	Transglobal Environmental Geochemistry
THM	Trihalomethane
TTHM	Total Trihalomethane
TTLC	Total Threshold Limit Concentration
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System
USGS	United States Geological Survey
UST	Underground Storage Tank
UV	Ultraviolet
VOC	Volatile Organic Compound



## **1.0 INTRODUCTION**

ENVIRON International Corporation (ENVIRON) has prepared this Corrective Measures Study (CMS) Report for the Chloroform Release Area on behalf of Hitachi Global Storage Technologies, Inc. (Hitachi GST) to address chloroform in the subsurface near former Building 028J located at 5600 Cottle Road, San Jose, California (“the Site”). Hitachi GST is planning redevelopment activities for this portion of the Site. This CMS Report for the Chloroform Release Area selects a corrective action alternative and describes the procedures for the remediation of chloroform-impacted soil, soil gas, and groundwater in the vicinity of the former Building 028J (“the former Building 028J Area”).

### **1.1 OVERVIEW**

In June 2005, David J. Powers & Associates (DJPA) prepared an Environmental Impact Report (EIR) for the proposed General Plan Amendment (GPA) and Planned Development (PD) Zoning on the approximately 321-acre Hitachi GST Site. The City of San Jose Planning Commission certified the Final EIR on June 6, 2005 (City of San Jose 2005a, 2005b). The Site, which is currently owned by Hitachi GST, was formerly owned and operated by International Business Machines (IBM). The location of the Site is shown on Figures 1 and 2. The Site layout prior to redevelopment is shown on Figure 3.

Hitachi GST has moved its research and development (R&D) and administrative office operations to a different location in San Jose (3403 Yerba Buena Road). A portion of land has been rezoned and will be sold and redeveloped into a mixed residential, commercial, and recreational open space area. The area to be redeveloped is divided into five Parcels (Parcel O-1 through O-5), as shown on Figure 4. In addition, Hitachi GST will be transferring ownership of Endicott Boulevard/Tucson Way, which borders the Site to the north, to the City of San Jose. For the purposes of this report, Parcels O-1 through O-5 and Endicott Boulevard/Tucson Way are hereafter referred to as “the Redevelopment Property”. The Redevelopment Property is approximately 143 acres.

Hitachi GST plans to continue industrial operations (developing and manufacturing of computer storage devices) on the remaining portion of the Site, termed “the Core Area”. All manufacturing-related activities currently located on Parcels O-1 through O-5 have been moved to the Core Area under the redevelopment plan. The Core Area is also shown on Figure 4.

The Hitachi GST Site is a large quantity generator (LQG) of hazardous waste and also maintains a Resource, Conservation and Recovery Act (RCRA) Permit for on-site storage and treatment of hazardous waste. The RCRA Permit encompasses the full 321 acres of the Site. Hitachi GST is

working with the California Environmental Protection Agency (CalEPA) Department of Toxic Substances Control (DTSC) to remove the Redevelopment Property from the RCRA Permit.

The purpose of this CMS Report for the Chloroform Release Area is to select a corrective action alternative and describe the procedures for the remediation of chloroform-impacted soil, soil gas, and groundwater in the former Building 028J Area in order to ensure that the Site is appropriately remediated prior to removal from the RCRA Permit.

## **1.2 BACKGROUND**

As part of the EIR, ENVIRON prepared a screening human health risk assessment (Screening HHRA) to evaluate the potential impacts on human health for Parcels O-1 through O-5. The overall objective of the Screening HHRA was to identify potential areas within Parcels O-1 through O-5 needing further investigation and/or mitigation prior to redevelopment. To accomplish this objective, the following steps were completed in the Screening HHRA: 1) determine the nature of historical operations and chemical use on Parcels O-1 through O-5; 2) compile and collect data regarding soil, soil gas and groundwater conditions in Parcels O-1 through O-5 to determine the site-specific chemicals of potential concern (COPCs); 3) develop risk-based target concentrations (RBTCs) for the COPCs within Parcels O-1 through O-5; and 4) compare the RBTCs to Parcel O-1 through O-5 data and determine which areas within these parcels require further investigation or mitigation measures. The RBTCs correspond to the level that would pose a *de minimis* health risk to future on-site populations.

The Screening HHRA was followed by a Current Conditions Report (CCR) (ENVIRON 2005a), which addressed Parcels O-1 through O-5 and Endicott Boulevard/Tucson Way. The Draft CCR plus the letter response to comments received from DTSC on the report (DTSC 2006) constitute the final CCR. Additional evaluation/investigation needed to fill data gaps identified in the Screening HHRA/CCR were addressed in the Soil Inspection/Sampling Plan (SI/SP) (ENVIRON 2005b) and its associated attachments.

The SI/SP was followed by a CMS Report for the Redevelopment Property (ENVIRON 2006). The CMS Report for the Redevelopment Property was prepared to address the presence of potential contamination in soil that may be encountered during building demolition and/or earthwork activities within the Redevelopment Property and/or discovered during implementation of the SI/SP. The CMS Report for the Redevelopment Property included residential remedial goals (RGs) for soil which were either the minimum residential RBTC or background concentrations.

Implementation of investigations conducted as part of the the SI/SP and the CMS Report for the Redevelopment Property were documented in the Final Remedy Completion Report for the Site (ENVIRON 2007b). In the Final Remedy Completion Report, the RBTCs were updated based on site-specific soil properties collected during investigations in 2007. For metals, the RBTCs did not change, and therefore they are the same as the RGs previously identified. For volatile organic compounds (VOCs), the RBTCs changed based on the new data. VOC data presented in this report have been compared to these updated RBTCs. Table 1 summarizes the lowest residential RBTCs for VOCs in soil, soil gas, and groundwater at the Site.

During implementation of the SI/SP, chloroform was discovered in soil, soil gas, and groundwater in the vicinity of the former Building 028J at levels exceeding the residential soil RG and soil gas and groundwater RBTCs. This CMS Report for the Chloroform Release Area was prepared to address chloroform impacts to soil, soil gas, and groundwater in the former Building 028J Area.

### **1.3 REPORT ORGANIZATION**

This CMS Report for the Chloroform Release Area is divided into seven sections as follows:

**Section 1.0 – Introduction:** describes the purpose and scope of the CMS Report for the Chloroform Release Area and outlines the report organization.

**Section 2.0 – Site Background:** presents an overview of the Site and the former Building 028J Area in particular, discusses former and proposed land uses, and describes characteristic features of the Site including topography and hydrogeology.

**Section 3.0 – Summary of Environmental Investigations:** summarizes previous investigations conducted in the former Building 028J Area.

**Section 4.0 – Corrective Action Objectives:** identifies the specific Corrective Action Objectives (CAOs) for the former Building 028J Area.

**Section 5.0 – Identification and Evaluation of Corrective Action Alternatives:** identifies and evaluates the remedial alternatives and selects an appropriate corrective action alternative for the former Building 028J Area.

**Section 6.0 – Corrective Action Implementation:** details the steps that will be taken to implement the selected corrective action.

**Section 7.0 – References:** includes the references cited in this report.

Supporting information is provided in the appendices. The appendices and their contents are as follows:

**Appendix A:** Soil Boring Logs and Well Completion Details

**Appendix B:** Results of Physical Testing

**Appendix C:** Cone Penetrometer Testing (CPT) Logs

**Appendix D:** Analytical Reports for April/May 2007 Groundwater Sampling

**Appendix E:** Partitioning Calculations and Estimates of Chloroform Mass

**Appendix F:** Results of 2-PHASE™ Extraction Pilot Test

**Appendix G:** Quality Assurance Project Plan (QAPP)

**Appendix H:** Health and Safety Plan (HASP)

## **2.0 SITE BACKGROUND**

The purpose of this section is to provide relevant information regarding the Site, and more specifically, the former Building 028J Area. This section includes a discussion of the Site history, areas surrounding the Site, future land use, groundwater use, topography, geology and hydrogeology.

### **2.1 SITE HISTORY**

The Site is located at 5600 Cottle Road in San Jose, Santa Clara County, California (Figures 1 and 2). The Site, which is currently zoned industrial, is approximately 321 acres in size. Prior to 1955, the Site was agricultural land, primarily tree orchards, with associated residences. In 1955, IBM purchased the Site. The Storage Technology Division of IBM owned and operated the Site from 1955 through 2002. IBM designed, developed, and manufactured computer storage devices, including hard disk drives, read/write heads, and disk storage media at the Site. On or about January 1, 2003, Hitachi GST, a new company formed as a result of a strategic combination of IBM and Hitachi's storage technology businesses, bought the Site.

As shown on Figure 3, approximately 30 buildings were present on the Site prior to commencement of redevelopment activities in August 2006. On-site buildings were used for a range of activities, including manufacturing, testing, assembly, research, development, wastewater treatment, reverse osmosis/deionized water production, utilities, chemical storage, other storage, security, offices, and cafeteria. Exterior areas of the Site primarily consisted of landscaped areas, orchards, sidewalks, water fountains, asphalt parking lots, and paved private roads. As discussed below, Hitachi GST will continue industrial operations (developing and manufacturing of computer storage devices) on the Core Area.

Two electrical substations located in the central-southeastern portion of the Site provide electricity to the Site. One 115-kilovolt (kV) substation, which contains a 50 megawatt (MW) electrical generator, is owned and operated by Hitachi GST; the other 115-kV substation is owned and operated by Pacific Gas & Electric (PG&E). Facility personnel reported that electricity for the Site is provided by PG&E, and Hitachi GST's generator is only operated for testing, when there is a major Site power outage or when PG&E requests that Hitachi GST provide electrical back up during peak demand periods. As discussed below, both electrical substations will remain.

In the early 1980s, chlorinated hydrocarbons were detected in soil beneath an on-site underground tank farm. Site-wide investigations showed that VOCs, primarily Freon 113, trichloroethene (TCE), 1,1,1-trichloroethane (TCA) and 1,1-dichloroethene (1,1-DCE) were present in groundwater beneath and downgradient of the Site. Subsequently, the Site has

undergone extensive remedial action including the remediation of solvent-impacted soil and extraction and treatment of on-site and off-site groundwater. Under an order from the Regional Water Quality Control Board, San Francisco Bay Region (RWQCB-SF) (Order No. R2-2002-0082 – Final Site Cleanup Requirements, as amended by Order No. R2-2007-0004), IBM is obligated to remediate the groundwater (RWQCB-SF 2002, 2007). According to Hitachi GST, on-site groundwater remedial actions are expected to continue for at least 10 years.

### **2.1.1 Former Building 028J History**

Former Building 028J, an approximately 2,000-square foot building, was located adjacent to the west of former Building 028 (see Figures 3 and 4). Former Building 028J was located outside and southwest of the chlorinated hydrocarbon impacted area discussed above, which IBM is currently remediating under the oversight of the RWQCB-SF. Former Building 028J was constructed in 1971 as the chemical and chemical waste storage area for former Building 028. According to Hitachi GST personnel, drums of solvents and cylinders of compressed gases were stored in former Building 028J from 1971 until approximately 1989. According to a map of former Building 028J dated 1984, the building was divided into two main chemical storage areas: “solvent storage area” and “user organics”. During ENVIRON’s Site visit, conducted as part the Phase I Environmental Site Assessments (ESAs) prepared by ENVIRON in 2003 and 2004, ENVIRON observed cracks within the concrete floor leading to drains in the former solvent storage area in former Building 028J. At the time of the Site visit, the cracks and drains appeared to have been sealed. Subsequent to 1989, former Building 028J was vacant for several years before it was used as a staging area for the Site’s landscaping contractor.

According to documents reviewed, an underground spill containment tank without secondary containment was located east of former Building 028J. This buried tank was removed in early-1982. An underground 300-gallon solvent spill storage tank was formerly located within the northern side of former Building 028J. This buried tank was removed in August 1986 as part of routine upgrading of facilities.

Industrial wastewater from former Building 028 was formerly collected in waste vault 03 (WV-03), which was located on the southeastern side of former Building 028J. The industrial wastewater was pumped from a series of underground pipes in concrete trenches to the on-site wastewater treatment plant (Building 110) on the Core Area. WV-03 and associated pipes were removed in 1989.

Former Building 028J was demolished in September 2006 as part of redevelopment activities. In April 2006 buried utilities in the former Building 028J Area were removed as part of the demolition of former Building 028.

## **2.2 SURROUNDING AREA**

The Site is located in a mixed industrial, commercial and residential area near the intersections of Monterey Highway, Blossom Hill Road, and United States Route 101, approximately seven miles southeast of downtown San Jose. Figure 2 shows the immediate Site vicinity, which includes the following:

- Cottle Road is located to the west, with a shopping center, other commercial buildings, a hospital/medical center, and a medium-high density residential area beyond.
- IBM Building 025 (formerly part of the Site), which is still owned by IBM, is located to the northwest. This parcel is the proposed location of a future Lowe's Store.
- Parcel O-6 (formerly part of the Site) is located to the northeast. Hitachi GST transferred ownership of Parcel O-6, which is approximately 11 acres, to the City of San Jose in November 2005. The planned land use for this parcel is a future City of San Jose Police Substation.
- Southern Pacific Railroad and Caltrain right-of-way, the Blossom Hill Caltrain Station, and Monterey Highway are located to the north, with medium to medium-low density residential and a commercial shopping area beyond.
- Highway 85 and the Cottle Road Light Rail Station are located to the south, with a hospital/medical center, library, day care, and single-family residential area beyond.

## **2.3 FUTURE LAND USE**

As previously discussed, Hitachi GST has moved its R&D and administrative office operations to a different location in San Jose (3403 Yerba Buena Road). In turn, most of the R&D and administrative office buildings at the Site (Buildings 010, 012, 018, 026, 028, 028J, and 051) have been demolished. Two buildings, Buildings 009 (office) and 011 (cafeteria), on the Redevelopment Property are considered historically significant and will remain intact.

The Redevelopment Property, which covers approximately 143 acres, has been divided into five “outer” parcels (Parcels O-1 through O-5) and includes Endicott Boulevard/Tucson Way, as shown on Figure 4. The next steps for the Redevelopment Property include rough grading and main utility/roadway installation by Hitachi GST. Parcels O-1 through O-5 (including the former Building 028J Area, which is located in Parcel O-4) will be sold and redeveloped into a mixed residential, commercial, and recreational open space area. Prior to property transfer, Hitachi GST is working with DTSC to remove the Redevelopment Property from the RCRA Permit.

Hitachi GST plans to continue industrial operations (developing and manufacturing of computer storage devices) on the Core Area. The Core Area contains all of the current manufacturing, chemical storage, waste storage, and wastewater treatment buildings/areas on the Site. All activities previously located on Parcels O-1 through O-5 have been moved to the Core Area under the redevelopment plan. There are no current RCRA-permitted sources in the Redevelopment Property. The existing PG&E substation will remain.

## **2.4 Groundwater Use**

The Site is a non-community, non-transient drinking water supplier and maintains a Water Supply Permit issued by the California Department of Health Services (DHS) Drinking Water Program. Six groundwater production wells currently provide drinking and process water for use on the Core Area. The drinking and process water wells, which are all located on the Core Area, are screened primarily in the lower B- and deeper aquifers, in the range of approximately 100 to 350 feet below ground surface (bgs). Based on documentation reviewed by ENVIRON, these aquifers have not been impacted by on-site releases. Groundwater sampling has indicated that the production wells are upgradient of the documented groundwater impacts. Two approximately 100,000-gallon water storage tanks, which hold water from the Site’s water production wells for domestic use, are located east of Building 021 (on the Core Area).

Five additional groundwater production wells were previously used to provide water for irrigation at the Site. Three of these irrigation wells were closed in 2006 and the remaining two wells are planned to be closed in September 2007.

The Site also maintains a connection with the Great Oaks Water Company, which utilizes groundwater from deep wells; however, facility personnel reported that the Site does not currently receive water from off-site sources.

IBM operates an on-site groundwater extraction and treatment systems as part of its remediation activities. Groundwater, which is treated at IBM’s on-site groundwater treatment facility, is



reused on-site. On-site reuse activities include the use of treated groundwater for irrigation and recharge into the aquifer. Two recharge wells (BR-1 and BR-2) are located near the northeastern Site boundary (on Parcel O-6, which was formerly part of the Site). IBM also maintains coverage under a National Pollutant Discharge Elimination System (NPDES) General Permit No. CAG912003 from the RWQCB-SF. The NPDES General Permit allows IBM to discharge treated groundwater from its groundwater remediation program to on-site storm drains (RWQCB-SF 2007).

According to the RWQCB-SF Order No. R2-2002-0082 (Final Site Cleanup Requirements) issued to IBM, institutional constraints are required to limit on-site exposure to acceptable levels. The institutional constraints include a deed restriction that notifies future owners of subsurface contamination and prohibits the use of shallow groundwater beneath the Site as a source of drinking water until cleanup standards are met (RWQCB-SF 2002). IBM is currently in the process of developing a Soils Management Plan (SMP) for the Site to address these restrictions.

## **2.5 Topography**

Based on a review of the United States Geological Survey (USGS) topographic map for the Santa Teresa Hills, California quadrangle, and ground surface elevations at the Site range from approximately 195 feet above mean sea level (msl) in the eastern portion of the Site to about 187 feet to the west near Cottle Road. The Site is situated on flat terrain, and the surrounding area is gradually sloped to the north.

Based on ENVIRON's review of Federal Emergency Management Agency (FEMA) electronic floodplain data, the Site is located in a 500-year flood zone.

## **2.6 Geology and Hydrogeology**

Numerous investigations have been conducted to characterize the geology and hydrogeology beneath the Site and in the surrounding area. The following sections summarize the information from these investigations.

### **2.6.1 Regional Geology**

The Site is located within the Santa Teresa Basin in the southern end of the Santa Clara Valley. To the north and east are the Yerba Buena Hills and to the south and west are the Santa Teresa Hills. A geologic study was conducted on the Santa Teresa Basin, where the Site is located, and the San Jose Plain, which is located downgradient of the Santa Teresa Basin. Edenvale Gap is the geographic boundary and hydraulic connection between the Santa Teresa Basin and the San Jose Plain.

The geology in the Santa Teresa Basin consists of alluvium extending below the ground surface to bedrock, which is present at depths ranging up to approximately 400 feet. The alluvium is about 140 feet thick at Coyote Narrows, 350 feet thick at Edenvale Gap, and may be more than 400 feet thick in the center of the basin. Most of the bedrock consists of consolidated sandstones, shales, cherts, serpentinite, and ultrabasic rocks. The region is tectonically active and faults are common in the bedrock. The Valley within the vicinity of the Site is delineated by the Silver Creek Block of the Diablo Range to the Northeast and New Almaden Block of the Santa Cruz mountains to the Southwest. Additionally, an outlier of the Sierra Azul Block can be found immediately south of the Site (USGS 1999). Two major fault systems, the San Andreas and the Calaveras, extend laterally alongside the Valley. However, compared with the overlying alluvium, the bedrock can be considered impermeable. No significant bedrock aquifers are known within the basin.

### **2.6.2 Site Hydrogeology**

Exploratory borings on the Site reveal alluvial deposits of clays and silts interbedded with sand and gravel layers (aquifers). The alluvium generally contains more than five silty-clay layers, which vary from a few feet to more than 30 feet in thickness separating more than six aquifers.

Fill materials at the Site are of variable thickness and properties. Moderately compacted fill ranging from depths of one to 18 feet have been encountered on-site. Beginning at the ground surface (or underlying surficial fill), there is a layer of medium plasticity clay that extends to a depth of about 5 to 10 feet bgs. Underlying deposits down to the aquifers (described below) vary across the Site, but primarily consist of additional clays and silts.

The aquifers are referred to as A, B, C, D, E, F, and G aquifers, with the A aquifer being the most shallow. The general depths of these aquifers below ground surface are as follows: A occurs between 20 to 50 feet; B lies between 50 and 95 feet; C is between 90 and 125 feet; D is between 140 and 160 feet; E is between 170 and 205 feet; F is between 230 and 260 feet; and G is between 270 and 275 feet. In some locations, the individual aquifers merge. All of these aquifer zones are hydraulically interconnected to some degree.

Groundwater measurements indicate that depths to shallow groundwater are currently approximately 30 feet or deeper, however, historically the recorded groundwater has been as shallow as 17 feet. This groundwater lowering is attributed to additional groundwater extraction in the Basin, including on-site groundwater extraction for treatment.

Groundwater flow directions in aquifer zones vary across the Site. Groundwater flow directions in the A-aquifer zone varies from south to northwest, while groundwater flow directions in the deeper aquifer zones are generally to the northwest.

### **2.6.3 Hydrogeology in the Former Building 028J Area**

Local Site subsurface conditions in the vicinity of former Building 028J have been evaluated using information from eight CPT soundings (CPT-1 through CPT-8) performed in April 2007; fifteen shallow groundwater wells (EW-1 through EW-15) installed by ENVIRON in April and May 2007; and from information available from previous investigations conducted at the Site by others. The locations of the CPTs and groundwater wells are shown on Figure 5 and groundwater elevations measured in May 2007 are shown on Figure 6. The installation of groundwater wells is discussed in detail on Section 3.2.9 and also in Section 7.2.

Consistent with prior investigations, ENVIRON identified three aquifers within 100 feet bgs. Information regarding these aquifers, as well as groundwater flow is discussed below. Detailed subsurface cross-sections are presented in Figures 7 through 9. Soil boring logs and well completion details are included as Appendix A and the results of physical testing of soils are included as Appendix B. The CPT logs are included as Appendix C.

In general, the Site is underlain by fill over natural alluvial deposits. The upper 10 feet of soil consists of clayey silts, silty fine sands, and sandy silts. These shallow soils contain residual concrete fragments and related construction debris from the demolition activities conducted in 2006 and early 2007. Observed natural soils below the fill consist of silty clays, clayey silts, and sandy silts to the top of the A-aquifer unit, which was encountered at depths ranging from 30 to 34 feet below ground surface. This is consistent with the pore water dissipation tests conducted during the CPT soundings where groundwater was encountered in the A-aquifer unit between approximate depths of 30 to 33 feet bgs.

The A-aquifer consists of a thin (two to four feet) layer of silty fine sand to fine sand with silt. This saturated sandy unit grades finer at the east and southeast of the Site in the vicinity of CPT-6, CPT-7, and CPT-8. Groundwater elevations in the A-aquifer, measured in May 2007 and shown on Figure 6, indicate an essentially flat potentiometric surface in the former Building 028J Area. This suggests that relatively stagnant groundwater conditions exist in the A-aquifer in this area of the Site.

The A-aquifer is underlain by a silty clay unit ranging from six to eight feet in thickness. This fine-grained confining layer reduces the potential for downward transport from the A-aquifer to the B-aquifer sand below. In this area, the B-aquifer was found to consist of a 12 to 18 feet thick interval of coarse-grained sediments ranging from sand to gravelly sand, the top of which was encountered between 40 and 44 feet bgs. At CPT-6, the top of the deeper C-aquifer sand was encountered at an approximate depth of 98 feet bgs. Soils between the base of the B-aquifer and the C-aquifer consisted of silty clay to clayey silt.

Based on the results of physical testing of soils, horizontal hydraulic conductivities for the A-aquifer range from  $10^{-3}$  centimeters per second (cm/s) at the center of the Site in the vicinity of EW-10 to  $10^{-6}$  cm/s at the southeast area of the site in the vicinity of EW-15. These test results, considered along with the results of CPT soundings, suggest that the A-aquifer is a relatively heterogeneous, but primarily fine-grained, unit with low to moderate permeability. Furthermore, vertical hydraulic conductivities of the fine-grained confining layer underlying the A-aquifer ranged from  $10^{-6}$  cm/s to  $10^{-7}$  cm/s providing further evidence that this layer acts as a barrier to vertical migration to the B-aquifer.

### **3.0 SUMMARY OF ENVIRONMENTAL INVESTIGATIONS**

Numerous environmental investigations have been conducted at the Site. Environmental investigations conducted relevant to the chloroform release area near former Building 028J are discussed below. Historical investigations of the former Building 028J Area, performed mainly by Harding Lawson Associates (HLA), are discussed Section 3.1. More recent investigations performed by ENVIRON are discussed in Section 3.2.

#### **3.1 Historical Investigations of the Former Building 028J Area**

Prior to implementation of the SI/SP, several investigations had been conducted in the vicinity of the spill containment tank, solvent tank, chemical storage room, and WV-03 associated with the former Building 028J Area to characterize the nature and extent of chemicals in environmental media. The results of these previous investigations were presented in detail in the CCR (ENVIRON 2005a) and are summarized below.

##### **3.1.1 Spill Containment Tank**

In early 1982, an underground spill containment tank with no secondary containment located east of former Building 028J was removed (HLA 1982; K/J/C 1987). The tank, which was buried approximately 10 feet bgs, was less than four feet in diameter and slightly more than four feet long. In July 1982, an investigation was conducted to characterize the chemical content of soil and groundwater beneath the spill containment tank. Two borings were drilled to a maximum depth of 43.5 feet bgs. Soil and groundwater samples were analyzed for 13 organic compounds, which represent all the chemicals that may have been in the tank during the period of its use. Freon 113, TCA, TCE, tetrachloroethene (PCE), chloroform, carbon tetrachloride, and acetone were detected in unsaturated soils and in groundwater. Ethyl amyl ketone, petroleum naphtha, kerosene, isopropyl alcohol, isophorone, and xylene were not detected above their respective detection limits. Freon 113 was detected up to 23 micrograms per kilogram ( $\mu\text{g/kg}$ ); TCA was detected up to 71  $\mu\text{g/kg}$ ; TCE was detected up to 40  $\mu\text{g/kg}$ ; PCE was detected up to 80  $\mu\text{g/kg}$ ; chloroform was detected up to 1,600  $\mu\text{g/kg}$ ; carbon tetrachloride was detected up to 6.7  $\mu\text{g/kg}$ ; and acetone was detected up to 5,100  $\mu\text{g/kg}$  in unsaturated soils. Based on information reviewed, no remedial actions appear to have been conducted following removal of the tank.

##### **3.1.2 Solvent Tank**

A buried 300-gallon solvent spill storage tank was removed during routine upgrading of facilities from within the northern side of former Building 028J on August 12, 1986 (HLA

1986a). When that underground storage tank (UST) was installed in approximately 1978, it was set in wet concrete, which formed a continuous saddle two to three inches thick at the base of the tank. The concrete saddle, which was approximately 3.5 feet bgs, was not removed as part of the tank excavation. The tank was intended to be used as a solvent spill storage tank, but the tank was never used. Two soil samples from two soil borings were collected from a depth of 4.5 feet bgs. One sample was collected beneath the east end of the concrete saddle and the other sample was collected beneath the west end. The soil samples were analyzed for total chromium, copper, nickel, and for chlorinated and non-chlorinated solvents. Results indicated TCE concentrations up to 10 µg/kg and metal concentrations within background ranges. The source of the TCE in the soil was unknown, but could be from the former nearby spill containment tank (discussed above). The report recommends investigating further the source of TCE in soils. The excavation was backfilled with clean, imported sand.

### **3.1.3 Chemical Storage Room**

In September 1986, an investigation was conducted to determine whether the Chemical Storage Room in former Building 028J or WV-03 (discussed below) were possible sources for the TCE found in the soils during previous investigations (HLA 1986b). Three soil borings were drilled to 10 feet bgs and one soil boring was drilled to 30 feet bgs beneath the Chemical Storage Room and WV-03. Eighteen soil samples from the four borings were collected and analyzed for Freon 113, TCA, TCE, methylene chloride, isophorone, and acetone. TCE was detected in samples from all four borings up to 33 µg/kg and TCA was detected in samples from two of the borings up to 9 µg/kg. The remaining constituents were not detected in any of the samples. According to the soil investigation report, the California DHS had not established an action level for TCE in soils; however, the IBM internal guideline was 500 µg/kg. Based on this internal guideline, it was concluded that no further investigations concerning TCE in soils at former Building 028J were necessary.

### **3.1.4 Former WV-03**

Industrial wastewater from Building 028 was formerly collected in WV-03, which was located on the southeastern side of former Building 028J. The industrial wastewater was pumped from a series of underground pipes in concrete trenches to the on-site wastewater treatment plant (Building 110) on the Core Area. WV-03 and associated pipes were removed in 1989 (HLA 1989a).

On April 25, 1989, four soil borings were advanced in a trench excavation located on the eastern side of WV-03. The borings in the trench excavation were advanced to a depth of approximately one foot below the trench bottom (five to seven feet bgs). On May 17, 1989, three borings were advanced through core holes in the bottom of the vault. The three borings were advanced to depths ranging from 3.5 to 3.7 feet below the vault floor. Additional soil samples were collected from the pipeline trench excavation to the west and north of Building 028.

Soil samples were analyzed for certain metals (total chromium, hexavalent chromium, copper, iron, nickel, and zinc). Hexavalent chromium was not detected. Total chromium was detected up to 94 milligrams per kilogram (mg/kg); copper was detected up to 63 mg/kg; iron was detected up to 68,000 mg/kg; nickel was detected up to 180 mg/kg; and zinc was detected up to 170 mg/kg. Metal concentrations in all samples were below the total threshold limit concentration (TTLC) level. In addition, one sample was analyzed for organics using United States Environmental Protection Agency (USEPA) Test Methods 8010, 8015, and 8020; no organic chemicals were detected. HLA concluded that no further action was necessary (HLA 1989a). The majority of the excavated soil from the pipeline removal was subsequently backfilled into the excavation.

### **3.2 ENVIRON Investigations of the Former Building 028J Area**

In the SI/SP, ENVIRON recommended soil sampling and a soil gas survey surrounding former Building 028J to determine the potential impacts to soils in these areas (SI/SP Attachment III – Soil Inspection/Sampling Plan for Buried Concrete Trenches, Building 028J and Former Waste Vaults 02-04 dated January 31, 2006). The results of these investigations, were presented in detail in the SI/SP Attachment III Completion Report (ENVIRON 2007a). In addition, ENVIRON conducted additional investigations in support of preparing this CMS Report for the Chloroform Release Area. The results of all of ENVIRON's former Building 028J Area investigations conducted to date are summarized below.

#### **3.2.1 November 2005 Soil Gas Investigation**

In November 2005, soil gas samples were collected from 20 locations along the former buried concrete trenches on the Redevelopment Property and around former Building 028J (SG-TR-1 through -18 and SG-028J-1 through -2). Soil gas sampling locations and results for chloroform in the former Building 028J Area are shown on Figure 10. In accordance with the SI/SP, the soil gas samples were collected from depths of five and 10 feet bgs at each location using a Geoprobe™-type direct push drilling rig. In general, the soil gas

samples were analyzed on-site by Transglobal Environmental Geochemistry (TEG) of Rancho Cordova, California using a mobile laboratory and USEPA Method 8260B. Roughly 10 percent of samples were collected in Summa™ canisters and sent to Calscience Environmental Laboratories, Inc. for analysis by USEPA Method TO-14.

The results of the soil gas sampling are summarized in Table 2. Compounds detected include trichlorofluoromethane (Freon 11), 1,1-DCE, Freon 113, 1,1-dichloroethane (1,1-DCA), cis-1,2-DCE, chloroform, 1,1,1-TCA, carbon tetrachloride, benzene, TCE, toluene, ethylbenzene, m,p-xylene, and o-xylene. Also included in Table 2 are the lowest residential soil gas RBTCs for five and 10 feet bgs. The only chemical that exceeds its residential soil gas RBTC is chloroform, which exceeded in both the five foot and 10 foot samples collected from SG-TR-11 and SG-TR-12 along the northeast side of former Building 028J at concentrations between 12 and 24 micrograms per liter (µg/L). Chloroform was detected in other samples collected near former Building 028J (specifically sample locations SG-TR-10, SG-TR-13, and SG-028J-2), but at levels below the lowest residential soil gas RBTCs of 1.1 µg/L and 1.9 µg/L at five and 10 feet bgs, respectively.

### **3.2.2 September 2006 Soil Investigation**

In September 2006, ENVIRON collected soil samples at varying depths between zero and 20 feet bgs from eight locations (28J-1 through 28J-8) within, and in the immediate vicinity of, the former Building 028J footprint. All samples were analyzed for VOCs (by USEPA Method 8260B), metals, and pH. As summarized in Table 3 and on Figure 11, the soil sampling results for VOCs showed that chloroform was present at 028J-3, 028J-4, 028J-7, and 028J-8 at or above the lowest residential soil RBTC of 8.7 µg/kg at depths between 15 and 20 feet bgs, with concentrations ranging from 8.7 and 17 µg/kg. In one boring (28J-4), chloroform was detected above the lowest residential soil RBTC at a depth of 11 feet bgs at a concentration of 14 µg/kg.. None of the metals detected were above the residential soil RGs and pH levels were in the range of native soil conditions.

### **3.2.3 December 2006 Soil Investigation**

In December 2006, ENVIRON advanced several additional borings in the vicinity of former boring 28J-4. As shown in Figure 11, the December 2006 sampling locations included four locations directly adjacent to 28J-4 (identified as borings 28J-A, 28J-B, 28J-D, and 28J-E), and six additional samples to the north, east, and south of 28J-4 in the vicinity of the buried concrete trench (borings 28J-C and 28J-F through 28J-J). Borings were advanced to 20 feet bgs and samples were generally collected every five feet. The soil samples were collected using Encore® samplers and submitted for analysis for VOCs by USEPA Method 8260B.



Chloroform and 1,1,2-trichloroethane (1,1,2-TCA) were the only VOCs detected. As summarized in Table 3, with the exception of location 28J-I, all of the soil samples collected at 15 and 20 feet bgs during the December 2006 event exhibited concentrations of chloroform above the lowest residential soil RBTC of 8.7 µg/kg. The concentrations of chloroform in soil at these locations ranged from 9.2 to 31 µg/kg. Chloroform was also detected above the lowest residential soil RBTC at a shallower depth (five feet bgs) in boring 28J-C, at a concentration of 18 µg/kg. 1,1,2-TCA was only detected in one sample, 28J-A, at a depth of five feet bgs at a concentration of 4.4 µg/kg, which is below the lowest residential soil RBTC of 7.9 µg/kg.

Two soil borings were also advanced in the vicinity of the WV-03 location in December 2006 (see Figure 11). Samples were collected from each boring (WV-03-1 and WV-03-2) from the native soil present immediately beneath the buried sand (a depth of approximately five feet bgs). As shown in Table 3, there were no VOCs detected above reporting limits in the samples.

#### **3.2.4 January 2007 Soil and Groundwater Investigation**

In January 2007, ENVIRON advanced six additional soil borings (028J-K through 028J-P) to the northwest of the former Building 028J along the former buried concrete trench. In addition, ENVIRON collected grab groundwater samples from four locations (GW-028J-C, -F and -O and GW-SG-028J-1) outside the former Building 028J. Soil and groundwater samples were submitted for analysis by USEPA Method 8260B. The soil and groundwater sample locations are shown on Figure 11 and 12, respectively. Soil borings were advanced to depths between 20 and 25 feet bgs, with soil samples generally collected every five feet. Grab groundwater samples were collected in the vicinity of soil borings 028J-C, 028J-F, 028J-O, and SG-028J-1, from depths ranging between 27 and 33 feet bgs. The soil and groundwater results are summarized in Table 3 and 4, respectively. Soil results for chloroform are shown on Figure 10 and groundwater results for chloroform are shown on Figure 12.

Chloroform was detected above the lowest residential soil RBTC of 8.7 µg/kg in two soil samples at depths between 15 and 20 feet bgs in soil borings (028J-L and 028J-M at concentrations between 9.1 and 11 µg/kg). All groundwater samples were below the lowest residential RBTC for chloroform of 380 µg/L. However, chloroform was detected in groundwater above the RWQCB-SF Cleanup Standard of 80 µg/L for chloroform in two

locations, GW-28J-C and GW-28J-F, at 170 and 320 µg/L, respectively.<sup>1</sup> Additional chemicals detected below residential groundwater RBTCs and available RWQCB-SF Cleanup Standards included TCA, 1,1-DCE, toluene, and total xylenes.

### **3.2.5 February/March 2007 Groundwater Investigation**

In February and March 2007, ENVIRON collected 10 additional grab groundwater samples (GW-028J-Q through GW-028J-Z) to the north, east, and south of the former Building 028J. The groundwater samples were submitted for analysis of VOCs by USEPA Method 8260B. The sample locations and results for chloroform are shown on Figure 12. The groundwater VOC results are summarized in Table 4. Groundwater grab samples were collected from depths ranging between 24 and 30 feet bgs.

Chloroform was detected above the RWQCB-SF Cleanup Standard of 80 µg/L in three locations, GW-028J-U, GW-028J-V, and GW-028J-W at concentrations of 890, 170, and 170 µg/L, respectively. The detected chloroform concentration in GW-028J-U also exceeded the lowest residential RBTC of 380 µg/L. Additional chemicals detected below residential RBTCs and RWQCB-SF Cleanup Standards included TCA and 1,1-DCE.

### **3.2.6 March 2007 Groundwater Investigation**

On March 12 and 13, 2007, ENVIRON collected 14 additional grab groundwater samples to the north and east of the former Building 028J. Sixteen grab groundwater locations were proposed (GW-028J-1 through GW-028J-16), but a sufficient volume of water could not be obtained from two sampling locations (GW-028J-11 and GW-028J-14). The groundwater samples were submitted for analysis of VOCs by USEPA Method 8260B. The groundwater sample locations and results for chloroform are shown on Figure 12. Groundwater grab samples were collected from depths ranging between 24 and 30 feet bgs. The groundwater results are summarized in Table 4.

Chloroform was detected in groundwater above the RWQCB-SF Cleanup Standard of 80 µg/L in four locations, GW-028J-8, GW-028J-9, GW-028J-10, and GW-028J-13 at concentrations of 810, 160, 130, and 120 µg/L, respectively. The detected chloroform concentration in GW-028J-8 also exceeded the lowest residential RBTC of 380 µg/L.

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<sup>1</sup> The cleanup standard for chloroform (80 µg/L) included in Table 3 (Groundwater Cleanup Standards) of IBM's RWQCB-SF Order No. R2-2002-0082 is referenced as the 2001 USEPA Maximum Contaminant Level (MCL). Chloroform does not have a specific MCL; rather, the MCL of 80 µg/L is for total

Additional chemicals detected below residential RBTCs and RWQCB-SF Cleanup Standards included TCE, TCA, 1,1-DCE, and 1,1-DCA.

### **3.2.7 March 2007 Soil Gas Investigation**

In March 2007, ENVIRON collected soil gas samples from 23 locations on an approximately 50 foot grid across and surrounding the former Building 028J footprint. Soil gas sampling locations are shown on Figure 10. The additional soil gas samples were collected from depths of five and 10 feet bgs at each location using a Geoprobe™-type direct push drilling rig.

The results of the soil gas sampling are summarized in Table 2. Results for chloroform are also shown on Figure 10. The only chemical that exceeded its residential soil gas RBTC was chloroform in both the five foot and 10 foot samples collected from SG-028J-3, SG-028J-4, SG-028J-6, SG-028J-7, and SG-028J-17 at concentrations ranging from 1.6 to 28  $\mu\text{g/L}$ . Chloroform was detected in other samples collected near former Building 028J, but at levels below the lowest residential soil gas RBTCs.

### **3.2.8 April 2007 B-Aquifer Groundwater Investigation**

On April 17 through 19, 2007 ENVIRON and their subcontractor, Holguin, Fahan, & Associates, Inc., advanced eight CPT soundings in the former Building 028J Area to further characterize subsurface conditions. The locations of the CPT soundings are shown on Figure 5 and detailed cross sections are presented in Figures 7 through 9. The CPT logs are included as Appendix C.

Following the CPT soundings, a Hydropunch® sampler was used to collect grab groundwater samples of the deeper B-aquifer from five of the CPT locations (CPT-1, CPT-2, CPT-5, CPT-6, and CPT-8) and analyzed for VOCs by USEPA Method 8260B. B-Aquifer groundwater sampling results are summarized in Table 5. The results for chloroform are also shown on Figure 13. The analytical report is included in Appendix D.

Chloroform was detected in two samples at concentrations below both the lowest residential RBTC of 380  $\mu\text{g/L}$ . These were locations CPT-5 and CPT-1 with chloroform concentrations of 34  $\mu\text{g/L}$  and 3.8  $\mu\text{g/L}$ , respectively. These concentrations are also below the RWQCB-SF Cleanup Standard for chloroform in the A-aquifer of 80  $\mu\text{g/L}$ . (There is no RWQCB-SF

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trihalomethanes (TTHMs), which includes chloroform, along with bromodichloromethane, dibromochloromethane, and bromoform.

Cleanup Standard listed in Order No. R2-2002-0082 for chloroform in the B-Aquifer.) Additional chemicals detected below residential RBTCs and RWQCB-SF Cleanup Standards included Freon 113 detected at all five sample locations at concentrations ranging from 0.53 to 0.82 µg/L and 1,1,1-trichloroethane detected at location CPT-5 at a trace level of 0.55 µg/L. No other VOCs were detected.

### **3.2.9 April/May 2007 Groundwater Well Installation and Sampling**

Groundwater sampling in the former Building 028J Area had been initially characterized from grab samples using direct-push drilling techniques. To confirm these results and to further assess groundwater conditions, groundwater wells were installed in the former Building 028J Area on April 23 through May 2, 2007. The well field was designed by ENVIRON to accomplish these goals and allow for subsequent use of the wells for extraction of subsurface vapor and groundwater. The well field consists of 15 groundwater wells (EW-1 through EW-15) and is shown on Figure 5.

The planned depths and well screen intervals for the groundwater wells were based on the CPT investigation results. However, the final construction details for each well were determined in the field. The top of screens were targeted at a nominal 15 feet bgs (minimum 12 feet bgs) to maximize vapor extraction in the vadose zone while minimizing surface intrusion of ambient air. In areas where there is a shallow zone of coarser materials, the top of the screen was adjusted downward to avoid these potential preferential pathways. To maintain the confining layer underlying the A-aquifer, the bottom of the wells were situated such that there was sufficient separation between the bottom of the boreholes and the top of the B-aquifer. Figure 7 through 9 display cross sectional details of the well field and the subsurface in the former Building 028J Area.

Well drilling was performed by Gregg Drilling & Testing, Inc., of Martinez, California using a hollow-stem auger drilling rig. During drilling activities relatively undisturbed soil samples were collected at five foot intervals in all borings, and two borings were continuously cored for stratigraphic logging purposes. Soil samples were collected using a California split-spoon sampler (2-inch inside diameter, 18 inches long) lined with pre-cleaned 6-inch long brass or stainless steel sample sleeves. Soil samples were logged and classified in accordance with the Unified Soil Classification System (USCS). Soil boring logs are included as Appendix A. Results of the physical testing of soils are included as Appendix B.

The wells were constructed of 4-inch diameter Schedule 40 polyvinyl chloride (PVC) casing and screen. The filter pack extends from the base of the screen to approximately two feet above the screen. A two-foot bentonite seal was placed above the filter pack, and a bentonite-cement grout seal was placed from the top of the bentonite pellet seal to just below ground surface. The wells were fitted with compression seals and were completed above grade with a concrete pedestals. Well construction details are summarized in Table 6.

Following installation, the wells were developed to produce groundwater that is relatively sediment free and representative of the water-bearing zone. Development activities were initiated at least 48 hours following placement of the grout seal so that sufficient time was provided to allow the seal to set. Development procedures for the wells consisted of bailing, surging (with a surge block), and pumping. Groundwater was removed from the wells until at least five casing volumes were removed, and readings of pH, temperature, and conductivity stabilized.

On May 7 through 9, 2007 ENVIRON gauged and sampled the groundwater wells in the former Building 028J Area in order to confirm previous grab groundwater sampling results and assess baseline groundwater conditions before implementation of a corrective action. Results of this assessment are summarized in Table 7. The groundwater results for chloroform are also shown on Figure 14. Analytical reports are included in Appendix D. The groundwater elevations are shown on Figure 6.

Groundwater concentrations of chloroform in the wells ranged from 2.0 to 920 µg/L with concentrations highest near the northeastern corner of the former Building 028J. Four of the wells (EW-4, EW-5, EW-9, and EW-10) had chloroform concentrations that exceeded the lowest residential RBTC of 380 µg/L. Eight of the 15 wells had chloroform concentrations exceeding the RWQCB-SF Cleanup Standard of 80 µg/L. Other VOCs detected at trace levels below the lowest residential RBTCs and RWQCB-SF Cleanup Standards included 1,1-DCE, 1,1-DCA, and 1,1,1-TCA. In general, results from this assessment confirmed the previously detected concentrations and the lateral extent of chloroform in groundwater.

## 4.0 SOURCE, NATURE, AND EXTENT OF CHLOROFORM

Because the source, nature, and extent of contamination in the subsurface will dictate the effectiveness of any corrective actions attempted, the following section provides a discussion of these factors for the COPC. Based on the previous investigations, chloroform is the only COPC identified in the former Building 028J area.

### 4.1 Potential Sources of Chloroform

Chloroform, known also as trichloromethane ( $\text{CHCl}_3$ ), is a colorless liquid with a sweet odor. It is one of the most frequently detected VOCs in groundwaters of the United States (Squillance et al. 1999; Grady 2003). Chloroform is both synthetically-produced and is naturally-occurring; however, the majority of chloroform in the environment is due to anthropogenic sources (ATSDR 1997). Chloroform can enter the hydrologic system from direct releases, intentional or inadvertent releases of chlorinated water or wastewater, dehalogenation of carbon tetrachloride (also known as tetrachloromethane or  $\text{CCl}_4$ ), and a variety of natural sources (USGS 2004). The primary source of chloroform detections in the groundwaters of the United States is likely due to contamination from chlorinated water and wastewater (USGS 2004). Chloroform, along with bromodichloromethane ( $\text{CHBrCl}_2$ ), dibromochloromethane ( $\text{CHBr}_2\text{Cl}$ ), and bromoform ( $\text{CHBr}_3$ ) are included in a class of chemicals called the trihalomethanes (THMs), which are commonly produced as a result of the disinfection of water and wastewater via chlorination. Primarily to address releases of these so called disinfection by-products (DBPs), the USEPA has established Maximum Contaminant Level (MCL) for total THM (TTHM) of 80  $\mu\text{g/L}$ .

However, chloroform contamination in the former Building 028J area appears to be due to direct release(s) to the subsurface. The elevated concentrations of chloroform identified in the subsurface and the lack of detections of other THMs supports this theory. As discussed in Section 3.1.1, chloroform (along with 12 other VOCs reported to have been stored in former Building 028J) was detected in unsaturated soils at concentrations up to 1,600  $\mu\text{g/kg}$  during an investigation conducted in 1982 to characterize the chemical content of soil beneath a spill containment tank located near WV-03, just outside former Building 028J. Subsequent investigations have identified elevated concentrations of chloroform in groundwater and soil gas in the vicinity. Although the information gathered to date supports direct release of chloroform from the spill containment tank as the primary contributor to subsurface chloroform, it is unknown if the elevated concentrations in the subsurface are the result of a single event or numerous small releases over time.

## 4.2 Fate and Transport of Chloroform

Contaminants that are introduced into the environment undergo various physical, chemical, and biological processes. The nature of the contaminant as well as the conditions of the environment into which it is released dictates the contaminant's fate (where it resides or what it becomes) and transport (the means and speed by which it travels in the environment). Understanding fate and transport is critical to assessing risks associated with a contaminant release as well as selecting methods for removing the contaminant from the environment.

The fate and transport of a contaminant are controlled by two disparate processes: transformation and partitioning. Transformation involves the changing of the contaminant into something else by biological or chemical reactions. Transformations can be advantageous if they make the contaminant less harmful (e.g., less toxic or less mobile), or they can be deleterious if the resulting compound is more harmful (e.g., more toxic or more mobile). Contrary to transformation, partitioning does not result in a change to the chemical structure of a contaminant, but rather involves the distribution of the contaminant between the various phases (e.g., air, water, and soil).

In general, chloroform is relatively inert in the subsurface and transformation reactions are therefore typically very slow (USGS 2004; ATSDR 1997). Therefore, partitioning is the primary process describing the fate and transport of chloroform in the subsurface. Chloroform is highly volatile (Vapor Pressure = 159 mm Hg at 20°C) and has a relatively high Henry's Law constant ( $K_H = 0.15$  at 25°C) when compared with other VOCs indicating that a significant portion of the chloroform mass in the subsurface will be in the vapor phase (existing as soil gas). However, chloroform is also relatively water soluble with a aqueous solubility of 7,920 mg/L, which dictates that a significant portion of the chloroform mass in the subsurface will be in the water phase (existing below the water table and as soil moisture in the vadose zone). Based on low measured values of organic carbon partition ( $K_{oc}$ ) coefficients ranging from 40 to 80 (ATSDR 1997), chloroform is not expected to adsorb significantly to soil organic carbon. Because of this, migration of chloroform through the saturated zone would be expected to be only moderately retarded in low-carbon aquifer materials as is the case for the former Building 028J area.

ENVIRON's soil investigations of former Building 028J conducted in September and December 2006 and January 2007 identified concentrations of chloroform in soil only slightly above the lowest residential RBTC with detected concentrations ranging from 5.0 to 31 µg/kg and existing generally below 15 feet bgs. Since no recent soil samples had chloroform concentrations near the maximum chloroform concentration of 1,600 µg/kg (detected during the initial Building 028J investigation in 1982), it appears that the dominant fate and transport process for chloroform of volatilization and groundwater leaching have diminished soil concentrations in the vicinity of

former Building 028J. Therefore, it is likely that the majority of the remaining mass of subsurface chloroform exists in groundwater; thereby providing a source of chloroform in soil gas.

#### **4.3 Horizontal and Vertical Extent of Chloroform**

Based on the solubility of chloroform, its low affinity for soil, and the presumed age of the release, it would be anticipated that lateral migration of chloroform through the saturated zone would have been significant. However, as is evidenced in groundwater sampling results to date, the chloroform-impacted area remains localized in the vicinity of former Building 028J. Figure 13 depicts the approximate lateral extent of elevated concentrations of chloroform in the former Building 028J area in soil gas and groundwater. This area is approximately 175 feet by 150 feet, or just over ½ acre in areal extent. Thus, it appears that the subsurface conditions are such that stagnant groundwater flow prevails within the A-aquifer in the vicinity of former Building 028J.

Subsurface investigations performed for IBM by Golder Associates, Inc., and MACTEC indicate that the A-aquifer, which ranges in thickness up to 30 feet, thins substantially towards the southern portion of the Site and exhibits low- or no-flow conditions in this area (Golder Associates, Inc. 2007; MACTEC 2006). Recent subsurface investigations performed by ENVIRON in 2006-2007 have shown that the A-aquifer is approximately 2-3 feet thick in the vicinity of former Building 028J and consists of fine-grained soils. Furthermore, groundwater elevations, measured by ENVIRON in May 2007, exhibited an essentially flat potentiometric surface with little or no hydraulic gradient in the former Building 028J area. These findings support the conclusion that stagnant flow conditions persist in the A-aquifer beneath former Building 028J minimizing dispersion of chloroform in groundwater. This has had the effect of limiting migration of chloroform to other areas of the Site and maintaining the elevated concentrations of chloroform to the former Building 028J area.

Vertical migration of chloroform is similarly limited. Soil concentrations of chloroform exceeding the lowest residential RBTC of 8.7 µg/L generally are limited to depths below 15 feet bgs. Shallow groundwater concentrations of chloroform exceeding the RWQCB-SF Cleanup Standard of 80 µg/L are limited to the A-aquifer which is encountered at a depth of approximately 32 feet bgs. Vertical migration below the A-aquifer is limited by an underlying layer of low-permeability clay ranging in thickness from six to eight feet. Due to the volatility of chloroform, these concentrations in shallow groundwater in the vicinity of former Building 028J provide a continuing source of chloroform to the vadose zone immediately above the impacted area in the form of soil gas.



#### **4.4 Partitioning of Chloroform and Estimates of Mass**

As discussed above, the partitioning of a contaminant in the subsurface is important to know in order to determine the feasibility of any corrective action. In the subsurface, there are various “compartments” where a contaminant may reside. These compartments include soil gas, soil moisture, and soil (sorbed) in the vadose zone and groundwater and soil (sorbed) in the saturated zone. Knowing the relative proportion of a contaminant in each compartment is important to identifying corrective action objectives and selecting a corrective action. Estimating the total mass of a contaminant is important to gauging the extent of the problem and assessing the effectiveness of a corrective action; however, in practice, the heterogeneity of the subsurface environment and the uncertainties involved in estimation of average values make absolute measures of contaminant mass problematic at best. Therefore, the estimates of chloroform mass and partitioning presented below should be used with discretion. Detailed estimation procedures and partitioning calculations are included as Appendix E.

The estimated total mass of chloroform in the subsurface in the vicinity of former Building 028J ranged from approximately two to four pounds. As stated previously, the uncertainty involved with this estimate is significant.

Based on the partitioning calculations, approximately 60-80% of subsurface chloroform exists in the vadose zone with the overwhelming majority of the vadose-zone mass dissolved in soil moisture with the balance existing in soil gas or sorbed to soil. Approximately 20-40% of subsurface chloroform exists in saturated zone with the majority dissolved in groundwater and a small amount sorbed to soil.

## 5.0 CORRECTIVE ACTION OBJECTIVES

The purpose of this Section is to identify the goals, objectives, and the scope of the corrective action. The overall CAO for the former Building 028J area is to prevent exposure of future occupants to elevated concentrations of chloroform in soil, soil gas, and groundwater. In addition, this area is part of the Hitachi GST Site, which is under a RCRA Part B permit, and therefore, remedial activities are being conducted under the review of DTSC in order for the Redevelopment Property to be removed from the RCRA-permitted facility boundary.

The specific CAOs for the former Building 028J Area are as follows:

- To the extent practicable, remediate chloroform-contaminated soil and soil gas in the vicinity of former Building 028J Area to levels at or below the site-specific residential RBTCs developed as part of the Remedy Completion Report; and
- To the extent practicable, remediate chloroform-contaminated groundwater in the vicinity of former Building 028J Area to levels below the site-specific residential RBTCs developed as part of the Remedy Completion Report and below the RWQCB-SF Cleanup Standard for chloroform of 80 µg/L specified for the Site in Order No. R2-2002-0082 – Final Site Cleanup Requirements, as amended by Order No. R2-2007-0004.

The RBTCs were developed as part of the HHRA/CCR and were subsequently recalculated based on additional information gathered during Site investigation. The RBTCs are discussed in detail in the Final Remedy Completion Report. RBTCs represent the concentration of a chemical that can remain in soil and still be protective of human health for future land use. The methodology used to develop the RBTCs is consistent with CalEPA, RWQCB-SF, and USEPA risk assessment guidance.

The proposed land use for the Redevelopment Property is residential, commercial, and open space (or park) use. Based on this proposed future land use, populations that could potentially be exposed to chemicals remaining in soil include residents (children and adults), commercial workers, and park visitors (children and adults). Additional populations on the Redevelopment Property could include short-term construction/maintenance workers during redevelopment or other short-term maintenance activities. RBTCs were calculated for each of these populations for all chemicals detected in groundwater (migration of vapors into ambient or indoor air), soil gas (migration of vapors into ambient or indoor air) and soil (ingestion, dermal contact, and inhalation of vapors or windblown dust). The full list of site-specific RBTCs is presented in the

Remedy Completion Report. The lowest RBTCs for residential land use are summarized for VOCs in Table 1. It should be noted that the lowest RBTCs for groundwater under a residential land use scenario (380 µg/L) is based on potential vapor migration into a home. The RWQCB-SF Cleanup Standard for chloroform (80 µg/L) is the Maximum Contaminant Level (MCL) for drinking water for total trihalomethanes (TTHMs), which includes chloroform, along with bromodichloromethane, dibromochloromethane, and bromoform. The final cleanup goal for groundwater at the Site is 80 µg/L. As the use of groundwater as a drinking water source is restricted, once the residential land use RBTCs are met there will be no significant risks to residents living on the property.

The National Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] § 300) is commonly cited as the basis for target risk and hazard levels. According to the NCP, lifetime incremental cancer risks posed by a site should not exceed one in a million ( $1 \times 10^{-6}$ ) to one hundred in a million ( $1 \times 10^{-4}$ ), and noncarcinogenic chemicals should not be present at levels expected to cause adverse health effects (i.e., Hazard Index (HI) greater than one). The RBTCs calculated as part of the HHRA/CCR correspond to a cancer risk of  $1 \times 10^{-6}$ . For noncancer health hazards, a target hazard index of one is identified. Individual chemical exposures that yield a hazard index of less than one are not expected to result in adverse noncancer health effects (USEPA 1989a).

In general, as a conservative screen, individual soil, soil gas, and groundwater samples will be compared directly to the RBTC. In many cases, if a single point concentration is greater than the RBTC, corrective actions will be continued or alternative measures will be implemented. In some cases where the single point concentration is above the lowest RBTC, an exposure concentration may be calculated according to USEPA and CalEPA risk assessment guidance.

According to USEPA, the exposure concentration term in the intake equation is the arithmetic average of the concentration that is contacted over the exposure period (USEPA 1989).

Although this concentration does not reflect the maximum concentration that could be contacted at any one time, it is regarded as a reasonable estimate of the concentration likely to be contacted over time, since assuming long-term contact with the maximum concentration is not reasonable. Because of the uncertainty associated with any estimate of exposure concentration, USEPA recommends that the 95 percent upper confidence limit (UCL) on the arithmetic average be used for this variable (USEPA 1989). The 95 percent UCL provides reasonable confidence that the true site average will not be underestimated (USEPA 1992).

Exposure concentrations below the RBTCs would support the conclusion that risks posed by residual chloroform in soil, soil gas, and groundwater at the Site are within acceptable limits.

The presence of exposure concentrations above or at the high end of this risk range may warrant additional remediation or risk management measures.

Once the corrective action has been completed, a risk assessment will be prepared for the former Building 028J area. In addition to comparisons to RBTCs, this risk assessment will evaluate cumulative risks in order to ensure that cumulative exposure to multiple chemicals detected within the Redevelopment Property will not result in risks above an acceptable level.

## 6.0 IDENTIFICATION AND EVALUATION OF CORRECTIVE ACTION ALTERNATIVES

The purpose of this section is to identify appropriate remedial technologies; to develop and formulate alternatives based on these technologies; and to evaluate relevant information concerning each alternative. This section consists of a preliminary review of alternatives, a screening of technologies, development of two remedy alternatives, evaluation of the alternatives, and the selection of an appropriate corrective action for the former Building 028J Area.

### 6.1 Preliminary Review of Alternatives

The preliminary review of remedial alternatives involved identification of alternatives capable of achieving the CAOs described in Section 5.0. The first step of this review involved consideration of several routinely-implemented alternatives. Summaries of these alternatives and the reasons for their elimination from further evaluation are presented below.

- *No Action* – This alternative assumes that no corrective action is required. This alternative considers natural attenuation as characterized to this point; however, it does not specifically include further monitoring and confirmation of natural attenuation in the future. In certain cases, low-risk sites are ready for closure when site characterization is complete and the risks posed have been evaluated. This option is favorable due to its low cost and low risk of exposure to Site workers and nearby residents from remedial activities. However, this alternative is not usually acceptable for VOC-impacted sites unless steps have been taken to remove VOCs from source areas to the extent that it is cost effective. In this case, feasible removal actions have not yet been implemented to address chloroform-impacted soil and groundwater in the former Building 028J Area. Thus, no action has been eliminated as a remedial alternative.
- *Monitored Natural Attenuation* – This alternative involves monitoring to track the progress of natural attenuation and to verify that concentrations decrease over time. The USEPA defines natural attenuation processes as those that include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil and groundwater. Monitored natural attenuation (also “MNA”) as a remedial option relies on physical, chemical, and biological processes such as dispersion, degradation, volatilization, and sorption to

attain remedial objectives (USEPA 1998). The benefits of this option include the low risk to Site workers and nearby residents from remedial activities, the potential lower overall remediation cost, and its flexibility to be used for all or part of a Site and/or in conjunction with other remedial options. In this case, the elevated concentrations of chloroform in the former Building 028J Area, the relative persistence of chloroform in the subsurface environment, and the current soil and groundwater conditions eliminate MNA as a remedial alternative at this time. However, monitored natural attenuation may be a viable alternative in the future after implementation of other remedial activities.

- *Soil Excavation* – The physical removal of impacted soil is a common remedial alternative that can usually be implemented in a relatively short period of time. Excavation is suitable for sites with shallow groundwater overlain by impacted soil and is easily implemented to depths of approximately 10 feet. Deeper excavations require larger machinery, shoring, and other engineering controls. In this case, due to the depth of the contamination, the amount of chloroform estimated to be below the water table, and the unique chemical properties of chloroform (volatility, solubility in water, and low affinity for soil organic carbon), excavation has been eliminated as a remedial alternative for the former Building 028J Area.

The next step of this review involved identifying potentially-viable technologies for remediation of chloroform in the former Building 028J Area. There are numerous technologies available for the remediation of VOCs; however, the feasibility of each varies widely depending on the specifics of the contaminant and the site. The following technologies (grouped according to type) were identified for further evaluation:

#### *Removal Technologies*

- Soil Vapor Extraction
- Dual-Phase or 2-PHASE Extraction
- Groundwater Extraction (Pump & Treat)
- Air Sparging

#### *Aboveground Treatment Technologies*

- Carbon Adsorption
- Chemical/UV Oxidation
- Thermal Oxidation

### *In-situ Treatment Technologies*

- In-situ Bioremediation by Gaseous Substrate Injection
- In-situ Anaerobic Bioremediation
- In-situ Chemical Oxidation
- In-situ Chemical Reduction with Zero Valent Iron

## **6.2 Screening of Technologies**

The potentially-viable technologies identified above were subjected to a screening based on technical feasibility. The primary screening criteria consisted of the technology's effectiveness with chloroform and its potential limitations given the Site conditions. Other factors considered in the analysis included cleanup time and cost. To aid the analysis, the technologies were classified according to type.

In general, the results of the technical screening show that the Site conditions and the nature and extent of chloroform (described in Section 4.0) limit the technologies capable of achieving the CAOs. The specific results of the technology screening are included in Table 8 and are discussed below for the three main types of technologies considered.

### **6.2.1 Removal Technologies**

Removal technologies consist of those intended to physically remove VOCs from the subsurface soil, soil gas, and/or groundwater. In general, removal technologies are not stand alone remediation alternatives, but require a means of treating VOCs following removal from the subsurface. Treatment is typically accomplished aboveground where the treatment processes are easier to monitor and control. Removal technologies are considered advantageous in this case because of their ability to potentially overcome the stagnant hydrogeologic conditions in the former Building 028J Area.

Both Soil Vapor Extraction and 2-PHASE™ Extraction were retained as suitable alternatives for concurrent soil and groundwater remediation at the former Building 028J Area. These technologies are widely used and are generally nonselective for removal of VOCs in the vadose zone. Furthermore, the high Henry's Law constant of chloroform indicates that significant mass transfer will occur from the aqueous phase to the vapor phase during treatment. 2-PHASE™ Extraction can further expedite treatment by removing contaminated groundwater from the A-aquifer in the former Building 028J Area and increasing flow through soil pore spaces formerly occupied by groundwater.

Groundwater Extraction (also known as, “Pump & Treat”) and Air Sparging were rejected as remedial alternatives during technical screening. Groundwater Extraction was rejected because the low-flow conditions within the A-aquifer in the former Building 028J Area would limit removal rates. Furthermore, an additional alternative would be necessary to address vadose-zone contamination. Air Sparging was rejected due to the potential for mobilizing chloroform in the subsurface (USEPA 2004a) thereby causing migration of chloroform to other areas of the Site.

### **6.2.2 Aboveground Treatment Technologies**

Aboveground treatment technologies include various treatment processes intended to destroy or remove VOC contamination. For subsurface contamination, a means must be in place to first remove the VOCs from contaminated soil, soil gas, and/or groundwater. Aboveground treatment processes are generally easier to monitor and control over in-situ technologies.

Carbon Adsorption was retained as an alternative for aboveground treatment of chloroform-contaminated vapor and groundwater. This is a relatively low cost and reliable treatment technology for treatment of VOC-contaminated water and vapor. However, the effectiveness with the specific waste streams from the former Building 028J Area will require a pilot test.

Chemical/Ultraviolet (UV) Oxidation and Thermal Oxidation were rejected as remedial alternatives during technical screening. Chemical/UV Oxidation was rejected because of its complexity of operation and the need for a separate vapor treatment alternative. Thermal Oxidation was rejected based on its marginal effectiveness with low influent vapor concentrations.

### **6.2.3 In-situ Treatment Technologies**

In-situ treatment technologies include those intended to treat VOC contamination in place. Treatment can consist of various chemical or biologically-mediated processes to destroy VOCs or otherwise reduce the toxicity or mobility of contamination in the subsurface. Typically, in-situ treatment technologies must be implemented below the water table because they require the solvent properties of groundwater to distribute the necessary amendments, which either stimulate favorable conditions for, or directly participate in, the desired reactions. Because of the complexities involved, in-situ technologies require detailed characterization of subsurface conditions to determine feasibility and the type and dosage of subsurface amendments required. Implementability varies from easy to difficult based on subsurface conditions. Extensive post-implementation monitoring is required to assess effectiveness and avoid potential unintended water quality issues.



In-situ Anaerobic Bioremediation and In-situ Bioremediation via Gaseous Substrate Injection were both rejected due to the problems caused by elevated chloroform concentrations in the subsurface. Above certain concentrations, chloroform becomes toxic to anaerobic and aerobic microorganisms (ATSDR 1997). Long et al. (1993) showed that in the absence of toxicity from other solvents, chlorinated hydrocarbons, or heavy metals, and where chloroform concentrations are below approximately 100 µg/L, both aerobic and anaerobic bacteria can degrade chloroform; however, deviations from these ideal conditions lead to low removal efficiencies.

In-situ Chemical Oxidation was rejected due to its limited effectiveness with chloroform and the potential need for high doses of oxidants. In-situ Chemical Reduction via Zero Valent Iron (ZVI) was rejected because of potentially slow reaction rates and the requirement of a separate remedial approach for chloroform-contamination in the vadose zone.

### **6.3 Corrective Action Alternatives**

The selection of corrective action alternatives reflects a preference for a permanent solution, incorporating approaches, where feasible and appropriate, which will reliably reduce toxicity, mobility, volume, or mass of contaminants.

The two alternatives that have been selected for evaluation are:

Alternative 1 Soil Vapor Extraction

Alternative 2 2-PHASE™ Extraction

A description and details regarding implementation of each alternative are presented below.

#### **6.3.1 Alternative 1 – Soil Vapor Extraction**

Soil Vapor Extraction (SVE) involves the induction of subsurface air flow to remove vadose zone VOCs. Air flow is created by the application of vacuum at one or more extraction wells screened in the vadose zone. The vacuum typically is produced by regenerative or positive displacement type electrical blowers.

As air is drawn through the soil during SVE, contaminants that volatilize into the vapor phase are carried along with the bulk movement of the air through more permeable regions in a process known as advection. Advection through low permeability regions is relatively slow. However, where concentration gradients exist between pores being swept by the flowing air

and contaminated soil not in communication with the airstream, contaminants will move by diffusion toward the flowing air. Generally, diffusion is much slower than advection and will limit the rate of contaminant removal from less permeable zones (USACE 2002). Fastest removal rates theoretically would occur in cases where contaminants are fully volatilized and reside in interconnected soil pores. In cases of contaminated groundwater, the rate of volatilization of contaminants from the aqueous phase is often limiting. However, based on the high Henry's Law constant of chloroform it is likely that a significant amount of mass transfer of chloroform from the aqueous phase would occur, making concurrent groundwater and soil gas remediation feasible to some extent.

Implementation of this alternative would include a pilot test to determine feasibility and aid in the design of the final design. It is expected that up to 15 extraction wells would be installed to achieve sufficient vacuum in the subsurface. The selection and placement of these wells would be based on the subsurface characteristics and the capture zone/radius of influence obtained during the pilot test. The extraction unit, capable of generating a vacuum of 15 inches of mercury or higher, would be leased. The extracted chloroform-impacted vapors would be treated by carbon adsorption and discharged to the atmosphere under a Bay Area Air Quality Management District (BAAQMD) permit.

### **6.3.2 Alternative 2 – 2-PHASE™ Extraction**

2-PHASE™ Extraction is similar to SVE in that a vacuum is applied to the subsurface inducing air flow to remove VOCs. However, 2-PHASE™ Extraction enhances the removal of VOCs by simultaneously extracting vapor and groundwater from conventional groundwater wells. It is very effective in low permeability soils, typically defined as having hydraulic conductivities less than approximately  $1 \times 10^{-4}$  cm/sec, but it also has been successfully applied to thin layers of higher permeability formations as well.

During 2-PHASE™ extraction, groundwater and vapors drawn into the well by the vacuum are removed from the well casing through a specifically-sized and positioned suction pipe or “stinger”. The induced vacuum draws vapor into the tip of the stinger at a velocity sufficiently high to entrain water and convey a water/vapor spray up the stinger and to the surface. The vapor and water phases are separated at the surface in a knock-out tank prior to treatment. The extraction of entrained water maintains the wells in a dewatered state, creates an unsaturated zone, and through continual dewatering of the wells desiccates the soil adjacent to the wells. This desiccation creates new air flow pathways, and enhances VOC vapor removal rates, especially as soil particles with sorbed VOCs become exposed.

Implementation of this alternative would include a pilot test to determine feasibility and aid

in the design of the final design. It is anticipated that up to 15 extraction wells would achieve sufficient vapor and hydraulic zones of influence in the subsurface. The selection and placement of these wells would be based on the subsurface characteristics and the capture zone/radius of influence obtained during the pilot test. The extraction unit, capable of generating vacuums of 18 to 29 inches of mercury and groundwater extraction rates of up to 15 gallons per minute (gpm), would be leased. The extracted chloroform-impacted vapor would be treated by carbon adsorption and discharged to the atmosphere under a BAAQMD permit. Extracted groundwater will be contained in closed-top holding tanks for subsequent treatment, reuse, and/or disposal. As the Site is a manufacturing facility with industrial water needs and having on-site water treatment facilities, there are opportunities for treatment and/or reuse of water on-site. Hitachi GST is currently investigating these alternatives based on technical feasibility, environmental soundness, and regulatory acceptance. One option that is being investigated is the use of the water at the on-site cooling towers as evaporative make-up water. This is a likely option if the characteristics of the extracted groundwater are determined to be appropriate for cooling tower use. Initially, however, the extracted groundwater would be treated on-site via IBM's air stripping and groundwater recharge system until the other alternatives can be investigated.

## **6.4 Comparative Analysis of Corrective Action Alternatives**

The two alternatives described above are subjected to comparative analysis below. Each alternative is evaluated on the basis of three criteria: effectiveness, implementability and cost. The criterion is described and followed by a comparative analysis of the two remedy alternatives.

### **6.4.1 Effectiveness**

In the effectiveness evaluation, the following factors are considered:

- *Overall Protection of Human Health and the Environment.* For the former Building 028J Area, this factor considers the ability of each alternative to meet CAOs. As discussed in Section 5.0, the overall corrective action goal for the former Building 028J area is to prevent exposure of future occupants to elevated concentrations of chloroform in soil, soil gas, and groundwater. Specifically, the goals are 1) to the extent practicable, remediate chloroform-contaminated soil and soil gas in the vicinity of former Building 028J Area to levels at or below the site-specific residential RBTCs developed as part of the Final Remedy Completion Report; and 2) to the extent practicable, remediate chloroform-contaminated groundwater in the vicinity of former Building 028J Area to levels below the site-specific residential RBTCs developed as part of the Final Remedy Completion Report, and below the RWQCB-SF Cleanup Standard for chloroform

specified for the Site in Order No. R2-2002-0082 – Final Site Cleanup Requirements, as amended by Order No. R2-2007-0004.

- *Reduction of Mobility, Toxicity, or Volume.* For the former Building 028J Area, this factor considers whether implementation of the corrective action will reduce the mobility, toxicity, or volume of chloroform in soil, soil gas, and groundwater.
- *Long-Term Effectiveness and Permanence.* For the former Building 028J Area, this factor considers whether the CAOs will continue to be met in the future under each alternative; and
- *Short-Term Effectiveness.* This factor evaluates the protection of public health during implementation of each alternative for the former Building 028J Area.

Alternative 1 and Alternative 2 both involve the active removal of chloroform from soil, soil gas, and groundwater in the former Building 028J Area; and based on the screening of other potentially-viable technologies, Alternative 1 and Alternative 2 represent the best available alternatives for achieving the CAOs. Alternative 1 and Alternative 2 are permanent solutions, so CAOs will continue to be met in the future. In addition, the short-term effectiveness of Alternative 1 and Alternative 2 are acceptable because both alternatives take appropriate measures to protect public health during implementation.

Alternative 2 is rated higher in effectiveness than Alternative 1 due to its potential for enhancing groundwater treatment in addition to soil vapor treatment.

#### **6.4.2 Implementability**

This criterion examines the technical and administrative feasibility of implementing the alternatives. Evaluation includes the availability of various services and materials required during implementation of the action, institutional or social concerns that could preclude the action, and State concerns that could impact implementation. In the implementability evaluation, the following factors are considered:

- **Technical Feasibility:** the ease or difficulty of implementing the alternatives and the reliability of the technology;
- **Administrative Feasibility:** those activities needed to coordinate with other offices and agencies, such as waivers or permits;
- **State Acceptance;** and

- Community Acceptance.

Alternative 1 and Alternative 2 both require pilot tests to confirm technical feasibility and both have permitting requirements prior to their implementation. There are no other known technical or administrative feasibility concerns with the implementation of the alternatives.

Alternative 1 and Alternative 2 are widely used for treatment of VOC-contamination and are likely acceptable alternatives to the state and community because they address short- and long-term protection of the community.

#### **6.4.3 Cost**

Due to similarity of Alternative 1 and Alternative 2, there are not significant cost differences between the two alternatives.

### **6.5 Recommended Alternative**

Alternative 1 and Alternative 2 both involve the active removal of chloroform from soil, soil gas, and groundwater in the former Building 028J Area; and based on the screening of other potentially-viable technologies, Alternative 1 and Alternative 2 represent the best available alternatives for achieving the CAOs. Alternative 2 is rated higher in effectiveness than Alternative 1 due to its potential for enhancing groundwater treatment. Therefore, Alternative 2 is the recommended alternative for implementation in the former Building 028J Area.

## **7.0 CORRECTIVE ACTION IMPLEMENTATION**

This Section details the steps that will be taken to implement the recommended correction action alternative – 2-PHASE™ Extraction. Implementation activities will be performed in accordance with all applicable federal, state, and local laws, regulations, and ordinances, as well as meet Hitachi GST corporate environmental policies. All field activities will follow the Health & Safety Plan for the Site, included in Appendix H. All sampling activities will follow the QAPP, included as Appendix G. Operation, monitoring, and maintenance procedures will be performed in accordance with the Operations, Monitoring, and Maintenance Plan (OMMP) to be prepared upon receipt of the BAAQMD permit and DTSC approval of this CMS Report for the Chloroform Release Area.

### **7.1 Implementation Schedule**

ENVIRON has extensive experience in applying 2-PHASE™ Extraction technology to sites impacted with VOCs under supervision of various agencies, including USEPA (Stringfellow in Glen Avon, California), Santa Ana RWQCB (various industrial sites), Los Angeles RWQCB (various industrial sites), RWQCB-SF (various industrial sites), San Gabriel Water Quality Authority (an industrial site in South El Monte, California). Based on this experience and current chloroform concentrations in the former Building 028J Area, remediation of soil, soil gas, and groundwater by 2-PHASE™ Extraction is likely to be achieved in less than one year of operation. However, the actual treatment time will depend on the long-term removal rates realized during operation.

ENVIRON estimates that the corrective action and post-remedial monitoring can be completed in less than two years from the start-up date of the 2-PHASE™ Extraction system. Currently, ENVIRON estimates that start-up of the 2-PHASE™ Extraction system can commence at the end of July 2007. Therefore, assuming this schedule is maintained, the entirety of the corrective action can be completed by August 2009.

To expedite the corrective action implementation, some of the implementation steps have already been completed. These steps include the installation of monitoring/extraction wells and 2-PHASE™ Extraction pilot testing (both discussed below).

### **7.2 Installation of Monitoring/Extraction Wells**

The flexibility of 2-PHASE™ Extraction allows installation of a well field consisting dual-use wells that can be easily switched from extraction to monitoring and vice versa. To maximize treatment efficiency and minimize treatment time, ENVIRON developed a well field for the

former Building 028J Area capable of treating the entire impacted area, or alternatively pulsing discrete zones while monitoring periphery wells. The monitoring/extraction well network is shown on Figure 5. A schematic of the 2-PHASE™ Extraction well heads is shown on Figure 15. Well construction details are summarized in Table 6.

The planned depths and well screen intervals for the monitoring/extraction wells were based on the CPT investigation results. However, the final construction details for each well were determined in the field. The top of screens were targeted at a nominal 15 feet bgs (minimum 12 feet bgs) to maximize vapor extraction in the vadose zone while minimizing surface intrusion of ambient air. In areas where there is a shallow zone of coarser materials, the top of the screen was adjusted downward to avoid these potential preferential pathways. To maintain the confining layer underlying the A-aquifer, the bottom of the wells were situated such that there was sufficient separation between the bottom of the boreholes and the top of the B-aquifer. Figures 7 through 9 display cross sectional details of the well field and the subsurface in the former Building 028J Area.

Well drilling was performed on April 23 through May 2, 2007 by Gregg Drilling & Testing, Inc., of Martinez, California using a hollow-stem auger drilling rig. The wells were constructed of 4-inch diameter Schedule 40 PVC casing and screen. Following installation, the wells were developed using standard methods to produce groundwater that is relatively sediment free and representative of the water-bearing zone. Well construction details are summarized in Table 6 and soil boring logs and well completion details are included as Appendix A. For a detailed discussion of the well drilling and construction, see also Section 3.2.9.

### **7.3 Pilot Test**

From June 4 through June 9, 2007, ENVIRON and its subcontractor, Drewelow Remediation Equipment, Inc., (DRE), conducted a pilot test of 2-PHASE™ Extraction at the former Building 028J Area to confirm feasibility of the remedial alternative and provide information to aid in the design and specification of the full-scale system. Detailed results of the pilot test are included as Appendix F.

Based on the results of the pilot test, 2-PHASE™ Extraction will be effective in removing chloroform from the subsurface in the former Building 028J Area. Water table drawdown was observed even at moderate extraction rates indicating hydraulic influence of the extraction wells is significant and that dewatering the A-aquifer to enhance vapor extraction is feasible. This demonstrates that selection of 2-PHASE™ Extraction over traditional SVE was appropriate in this case.

## **7.4 System Design and Technical Specification Preparation**

Based on the results of the pilot test and ENVIRON's knowledge of Site conditions the 2-PHASE™ Extraction system will consist of a Rietschle VLR-500 high vacuum blower package with a pump-down vapor/liquid separator (knock-out tank) leased from DRE on a monthly basis. This unit is capable of producing vacuums of up to 25 inches of mercury, vapor flow rates of up to 300 cubic feet per minute (cfm), and groundwater extraction and transfer rates of up to 15 gpm, although the anticipated groundwater extraction rate is likely only one to two gpm. Figure 16 depicts the process flow diagram of the 2-PHASE™ Extraction unit.

The unit is skid-mounted and will be installed near the extraction well field. The extraction unit will be connected to a treatment system consisting of two 1,000-pound vapor-phase granular activated carbon (GAC) vessels installed in series to treat the extracted vapors. The supplied GAC will consist of virgin coconut shell carbon. The extraction unit will be equipped with a heat exchanger for humidity control to increase the efficiency of carbon adsorption. Change-out of GAC will occur on an as needed basis, determined by measurements of influent and effluent vapor concentrations in accordance with the BAAQMD permit conditions. The spent carbon will be removed from the carbon adsorption vessels by vacuum truck and transported by the carbon vendor for subsequent recycling and/or disposal. Extracted groundwater will be contained in closed-top holding tanks for subsequent treatment, reuse, and/or disposal. As the Site is a manufacturing facility with industrial water needs and having on-site water treatment facilities, there are opportunities for treatment and/or reuse of water on-site. Hitachi GST is currently investigating these alternatives based on technical feasibility, environmental soundness, and regulatory acceptance. One option that is being investigated is the use of the water at the on-site cooling towers as evaporative make-up water. This is a likely option if the characteristics of the extracted groundwater are determined to be appropriate for cooling tower use. Initially, however, the extracted groundwater will be treated on-site via IBM's air stripping and groundwater recharge system until the other alternatives can be investigated. Furthermore, as a contingency measure, some of the extracted water may also be transported via vacuum truck by commercially-licensed vendor for off-site treatment/disposal.

## **7.5 Permitting**

Following treatment with GAC, extracted vapors will be discharged to the atmosphere under a BAAQMD permit. ENVIRON has submitted a BAAQMD accelerated permit application for the operation of the 2-PHASE™ Extraction system.

As discussed in Section 7.4, extracted groundwater will be contained in closed-top holding tanks for subsequent treatment, reuse, and/or disposal. Hitachi GST is currently investigating



alternatives for groundwater treatment and/or re-use on-site. The likeliest and most desirable of these alternative is to use the extracted groundwater as cooling tower make-up water. However, until this and any other of the re-use alternatives can be fully investigated, extracted groundwater will be conveyed to IBM's on-site groundwater recharge system for treatment in an air-stripping column and subsequent re-injection or discharge. This remediation system operates under the IBM Site Cleanup Requirements, RWQCB-SF Order No. R2-2002-0082, as amended by R2-2007-004, which allows recharge of treated groundwater. Discharge of treated groundwater to the storm drain is regulated by NPDES General Permit No. CAG912003. The on-site groundwater recharge system's air stripper operates under a BAAQMD permit which is assigned to the current IBM Cottle Road operations Plant #14919; the air stripper has been assigned Source #676.

## **7.6 Waste Management**

Soil cuttings generated during well drilling were contained in Department of Transportation (DOT)-approved closed-top bins for subsequent testing and disposal. Each bin was sealed and labeled with the boring numbers, depth intervals (when appropriate), and date. The bins were sampled for profiling purposes and were subsequently transported under manifest by Denbeste Transportation, Inc. of Windsor, California on June 7, 2007 to Altamont Landfill in Livermore, California.

Routine waste generation during the corrective action will include extracted groundwater, purge and decontamination water generated during sampling events, and spent GAC from the carbon adsorption vessels. Purge water and decontamination water will be handled in the same manner as the extracted groundwater as described in Section 7.5. Spent carbon will removed from the carbon adsorption vessels by vacuum truck and transported off-site by the carbon vendor for subsequent profiling. Depending on the results of profiling, the carbon will be recycled or disposed at an appropriate facility.

## **7.7 System Installation and Start-up**

Prior to the pilot test, ENVIRON and its subcontractor constructed the extraction well heads, and installed the well field conveyance piping and the extraction manifold. The extraction well heads consist of steel compression caps with sampling ports for measurements of vacuum and groundwater levels. The suction pipes, or stingers, consist of 1-inch diameter, Schedule 40 PVC pipe generally placed six to 12 inches above the static water level. Clear plastic "windows" are installed at the top of the stingers to allow qualitative estimates of the extracted air/water ratio. A schematic showing the 2-PHASE™ Extraction well heads is included as Figure 15. Connections from the well heads to the conveyance piping consist of UV-resistant, wire

reinforced flex hose rated at 50 pounds per square inch (psi). The piping between the wells and the extraction manifold are constructed of standard 2-inch diameter, Schedule 40 PVC. To avoid trenching activities the piping is installed above ground. The extraction manifold is also constructed with 2-inch diameter Schedule 40 PVC with valves allowing isolation and operation of any well, or sets of wells, in the network.

Upon receipt of permits and the full-scale extraction unit, ENVIRON and DRE installed the equipment and made the necessary final connections to the well field. When the system installation was completed, equipment was checked for proper operation, and piping and fittings were checked for leaks by low pressure testing.

An initial assessment of the system's effectiveness and efficiency is currently being conducted. During this initial period of operation, the mechanical components of the system are being closely monitored to assess whether the system is operating properly and determine how best to operate the system. VOC concentrations in vapor and water are being routinely monitored to ensure compliance with discharge limits and to assess mass removal rates.

During this startup period, it is expected that weekly vapor samples will be collected from the influent and effluent ports of the carbon treatment system. Additional vapor samples will be collected as necessary to optimize system operation and estimate mass removal. The vapor samples will be sent under chain-of-custody protocols to Calscience Environmental Laboratories, Inc., of Garden Grove, California for analysis by USEPA Method TO-15 for VOCs.

## **7.8 System Operation, Monitoring, and Maintenance Program**

Detailed operations, monitoring, and maintenance procedures will be contained in the OMMP. The OMMP contains information on contact telephone numbers, equipment specifications and manuals, start-up/shutdown procedures, monitoring/sampling procedures and forms, and permits. The OMMP will be prepared upon receipt of the BAAQMD permit and DTSC-approval of the this CMS Report for the Chloroform Release Area. The OMMP will be continually updated to reflect changes in operations, equipment, and/or procedures.

It is intended that the systems will operate on a 24-hour basis; therefore, the system design will include built-in alarms and shutdown mechanisms should system problems arise. ENVIRON or its equipment provider, DRE, will respond to the shutdown by visiting the Site, inspecting/repairing the equipment as necessary, and restarting the system.

The system will be inspected weekly to make adjustments and/or repairs, as needed, and monitor the system including recording operating parameters, and collecting system performance/compliance water and vapor samples. On a weekly basis, personnel will collect vapor samples from the influent and effluent ports of each carbon vessel using a photoionization detector (PID). Every two weeks, ENVIRON will collect vapor samples from the influent port of carbon treatment system to evaluate the performance of the extraction unit. On a monthly basis, ENVIRON will collect vapor samples from the effluent port of the carbon treatment system to comply with anticipated BAAQMD permit conditions. Sampling frequencies will be adjusted to comply with the actual conditions stated in the final BAAQMD permit. The samples will be sent under chain-of-custody protocols to Calscience Environmental Laboratories, Inc., of Garden Grove, California for analysis by USEPA Method TO-15 for VOCs.

ENVIRON will also collect a sample of extracted groundwater on a monthly basis, or as otherwise needed to assess system performance. These samples will be sent to Severn Trent Laboratories, Inc., (STL) of Pleasanton, California and analyzed by USEPA Method 8260B for VOCs.

In all cases, monitoring and sampling frequencies may be adjusted depending on system performance and field conditions.

During system operation, the mass removal rates will be calculated and compared to the carbon adsorption curves to evaluate the carbon change-outs that will be required during the life of the project. Additionally, samples will be collected as necessary to assess mass removal efficiency and to fine tune the extraction scheme at the Site. If necessary, corrective measures will be implemented, which may include the following: addition of GAC beds for treatment of extracted water and vapor, adjustment of stinger depths, altering flow rates, temporary system shutdowns to maximize operational efficiency (temporal pulsing), and/or turning on and/or off individual extraction wells to isolate certain zones (zone pulsing).

## **7.9 Performance Evaluation and Reporting**

During the first three months of operation, ENVIRON will submit monthly reports to describe the status of the remediation system and a summary of operating conditions. Thereafter, the reports will be submitted on a quarterly basis. Information in these reports will include:

- Hours of operation during the reporting period;
- Flow rates and vacuum;
- Water levels;
- Influent and effluent concentration of VOCs in the extracted vapors;

- Concentration of VOCs in the extracted groundwater;
- Summary of non-routine repairs or modifications, if any;
- Date and time of sampling;
- Mass removal rates and total mass removed;
- A table summarizing the laboratory results, and
- Laboratory results and chain-of-custody documents.

As part of the performance evaluation, the concentrations of chloroform in the extracted vapor and groundwater will be reviewed to assess mass removal efficiency. If necessary, modifications will be made to enhance the remediation system performance.

### **7.10 System Shutdown**

Based on experience, VOC concentrations in soil and groundwater typically decline rapidly in the first several months of operation of a 2-PHASE™ Extraction system, monitored by the change in concentration in the extracted vapor. Generally, in a time-frame of 12 months or less of operation, the concentrations in extracted vapor reach a steady state or asymptotic level with no further significant drop in concentrations in soil and groundwater. In some cases, asymptotic conditions occur before cleanup goals have been reached.

In general, permanent system shutdown and post-remedial monitoring will be initiated once one, or all, of the following has occurred: soil gas and groundwater concentrations of VOCs meet CAOs, steady-state residual concentrations of VOCs have been determined not to pose a significant threat to future occupants, and/or mass removal rates during continuous and pulsed modes no longer justify continued operation of the extraction system. For the latter case, an alternate remedial approach may be warranted.

In this case, the extraction system will be operated, to the extent practicable, until the CAOs are met. The primary performance criteria will be the concentrations of chloroform in extracted vapor and groundwater. If extracted concentrations of chloroform remain elevated, the system will be operated continuously. However, if extracted concentrations of chloroform decrease significantly, these conditions may warrant temporary or permanent system shutdown.

Decisions on shutdown will be based on a review of the extracted chloroform concentrations and secondary performance criteria, which include vapor flow rates, applied vacuum, vacuum radius of influence, groundwater extraction rates, and water table drawdown measurements. These additional criteria will be used to decide whether changes in operation, including temporal or zone pulsing of the system, may increase removal rates or otherwise improve the effectiveness of remediation. If changes are not likely to improve performance; temporary system shutdown

followed by interim monitoring of soil gas and groundwater will be implemented to assess in-situ chloroform concentrations.

Interim monitoring will consist of monthly monitoring of groundwater collected from the monitoring/extraction wells and soil gas collected from temporary or semi-permanent soil gas probes placed at intermediate points between monitoring/extraction wells. If chloroform concentrations in the soil gas probes and groundwater meet CAOs for three consecutive months, we will evaluate whether the 2-PHASE™ Extraction system will be permanently shutdown and equipment<sup>2</sup> demobilized. At this time, it is anticipated that limited redevelopment activities could commence in the former Building 028J Area while post-remedial monitoring continues as described below.

If chloroform concentrations in the soil gas probes are below the CAOs for three consecutive months, but groundwater concentrations are above CAOs, the 2-PHASE™ Extraction system may be modified such that redevelopment activities could commence in the former Building 028J Area. Under this scenario, remedial monitoring activities would continue, but the remediation and monitoring system would be modified to accommodate redevelopment activities.

If chloroform concentrations in the soil gas probes increase and no longer meet CAOs, monitored concentrations in groundwater will be reviewed to determine if the system should return to operation or whether another remedial alternative (e.g. monitored natural attenuation) should be implemented.

### **7.11 Post-Remedial Monitoring**

Based on experience, concentrations in groundwater and soil gas tend to increase or “rebound” to some extent several months after implementation of 2-PHASE™ Extraction. The amount of rebound is site-specific and can not be estimated with any certainty. Therefore, post-remedial monitoring will be implemented to assess rebound of chloroform concentrations in the former Building 028J Area. Post-remedial monitoring will consist of monthly monitoring of groundwater and soil gas concentrations for an additional three months following equipment demobilization. If after three months of post-remedial monitoring (i.e., after demobilization) the risk assessment for this area show risks are within acceptable ranges for residential land use, redevelopment activities could continue unmitigated. If rebound is deemed unacceptable, the extraction system may be returned to operation, or another remedial alternative (e.g. monitored natural attenuation) may be employed.

## **7.12 Completion Report**

A Completion Report, documenting all activities conducted pursuant to an approved CMS Report for the Chloroform Release Area and certifying that all activities have been conducted consistent with this CMS Report for the Chloroform Release Area, will be prepared as expeditiously as possible upon completion of the remedy and submitted to the DTSC for review and approval.

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<sup>2</sup> This includes removal of the 2-Phase<sup>TM</sup> Extraction equipment but not groundwater or soil vapor extraction wells or probes.

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## **TABLES**

**TABLE 1: SUMMARY OF THE LOWEST RESIDENTIAL RISK BASED TARGET CONCENTRATIONS FOR VOLATILE ORGANIC COMPOUNDS**

**Corrective Measures Study Report - Former Building 028J Area**

**Hitachi Global Storage Technologies, Inc.**

**5600 Cottle Road, San Jose, California**

Chemical	Environmental Media				
	Groundwater (ug/L)	5' Soil Gas (ug/L)	10' Soil Gas (ug/L)	15' Soil Gas (ug/L)	Soil (ug/kg)
Acetone	6.2E+06	----	----	----	2.0E+05
Benzene	7.3E+01	2.4E-01	4.1E-01	2.0E+00	----
Bromomethane (Methyl bromide)	----	9.3E+00	1.6E+01	7.9E+01	----
2-Butanone	1.1E+07	----	----	----	----
Carbon tetrachloride	5.1E+01	1.8E-01	3.1E-01	1.6E+00	----
Chloroethane	4.0E+06	6.5E+03	1.0E+04	4.8E+04	----
Chloroform	3.8E+02	1.1E+00	1.9E+00	8.9E+00	8.7E+00
Dibromofluoromethane	----	----	----	----	----
1,1-Dichloroethane	1.2E+03	4.9E+00	8.5E+00	4.2E+01	----
1,2-Dichloroethane	1.2E+02	2.9E-01	4.9E-01	2.0E+00	----
1,1-Dichloroethene (Ethylene dichloride)	3.0E+04	1.1E+02	1.9E+02	9.7E+02	----
cis-1,2-Dichloroethene	1.5E+04	6.5E+01	1.1E+02	5.4E+02	----
trans-1,2-Dichloroethene	2.8E+04	1.4E+02	2.4E+02	1.2E+03	----
Ethylbenzene	----	3.7E+03	6.4E+03	3.2E+04	----
Freon 11 (Trichlorofluoromethane)	----	8.9E+03	1.6E+04	8.5E+04	----
Freon 12 (Dichlorodifluoromethane)	6.6E+04	4.1E+02	7.2E+02	3.8E+03	4.7E+02
Freon 113 (Trichlorotrifluoroethane)	9.2E+06	5.4E+04	9.3E+04	4.9E+05	2.3E+05
Freon 114 (Dichlorotetrafluoroethane)	----	8.9E+04	1.6E+05	8.3E+05	----
Isopropanol	4.3E+07	----	----	----	----
Methyl chloride (Chloromethane)	1.7E+03	2.8E+00	4.7E+00	2.4E+01	----
Methylene chloride (Dichloromethane)	1.9E+03	6.1E+00	1.0E+01	4.7E+01	5.0E+01
Tetrachloroethene	4.0E+02	1.4E+00	2.4E+00	1.2E+01	----
Toluene	1.6E+05	4.8E+02	8.3E+02	4.1E+03	----
1,1,1-Trichloroethane (Methyl chloroform)	5.2E+05	1.8E+03	3.1E+03	1.6E+04	4.7E+03
1,1,2-Trichloroethane	1.8E+02	----	----	----	7.9E+00
Trichloroethene	1.1E+03	3.8E+00	6.5E+00	3.3E+01	2.6E+01
1,2,4-Trimethylbenzene	----	1.1E+01	1.9E+01	9.4E+01	----
1,3,5-Trimethylbenzene	----	1.1E+01	1.9E+01	9.5E+01	----
Vinyl chloride	2.0E+01	7.6E-02	1.3E-01	6.6E-01	----
m,p-Xylene	----	1.3E+03	2.2E+03	1.1E+04	----
o-Xylene	3.4E+05	1.1E+03	1.9E+03	9.4E+03	----
Xylenes, Total	3.9E+05	----	----	----	----
Total Volatile Hydrocarbons (TVH)	----	1.1E+02	3.9E+02	7.3E+02	----

**Notes:**

Lowest Risk-Based Target Concentrations (RBTCs) for residential land use as presented in the Final Remedy Completion Report for the Redevelopment Property (Source: Final Remedy Completion Report, Redevelopment Property, Hitachi Global Storage Technologies, Inc., 5600 Cottle Road, San Jose, California. Prepared by ENVIRON, August, 2007 ).

ug/L = microgram per liter

ug/kg = microgram per kilogram

---- = not available

TABLE 2: SUMMARY OF SOIL GAS SAMPLE RESULTS IN THE FORMER BUILDING 028J AREA

Corrective Measures Study Report - Former Building 028J Area

Hitachi Global Storage Technologies, Inc.

5600 Cottle Road, San Jose, California

Location ID	Depth (feet bgs)	Sampling Date	Soil Gas Concentration (ug/L)																		TVH	1,1-DFA	
			Benzene	CT	Chloroform	1,1-DCA	1,1-DCE	Ethyl- benzene	Freon 11	Freon 12	Freon 113	Methyl chloride	Methylene chloride	PCE	Toluene	1,1,1-TCA	TCE	1,2,4- TMB	1,3,5- TMB	m,p-Xylene			o-Xylene
Lowest Residential RBTC - 5 feet bgs <sup>[1]</sup>			0.24	0.18	1.1	4.9	110	3,700	8,900	410	54,000	2.8	6.1	1.4	480	1,800	3.8	11	11	1,300	1,100	110	N/A
Lowest Residential RBTC - 10 feet bgs <sup>[1]</sup>			0.41	0.31	1.9	8.5	190	6,400	16,000	720	93,000	4.7	10	2.4	830	3,100	6.5	19	19	2,200	1,900	390	N/A
SG-028J-1	5	11/18/2005	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	<b>0.13</b>	< 0.080	< 0.080	----	----	<b>0.16</b>	< 0.080	<b>6.4</b>	----
SG-028J-1	10	11/18/2005	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.091</b>	----	< 0.080	< 0.080	<b>0.095</b>	<b>0.20</b>	< 0.080	----	----	<b>0.12</b>	< 0.080	< 5.0	----
SG-028J-1 <sup>[3]</sup>	10	11/18/2005	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.080</b>	----	< 0.080	< 0.080	<b>0.14</b>	<b>0.19</b>	< 0.080	----	----	<b>0.17</b>	< 0.080	< 5.0	----
SG-028J-2 <sup>[3]</sup>	5	11/21/2005	< 0.011	< 0.022	< 0.017	< 0.014	< 0.014	< 0.015	< 0.039	< 0.017	< 0.053	----	< 0.048	< 0.023	< 0.013	<b>0.088</b>	< 0.019	----	----	< 0.030	< 0.015	----	<b>370</b>
SG-028J-2	5	11/18/2005	< 0.080	< 0.080	<b>0.23</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.22</b>	----	< 0.080	< 0.080	<b>0.088</b>	<b>0.36</b>	< 0.080	----	----	<b>0.10</b>	< 0.080	< 5.0	----
SG-028J-2	10	11/18/2005	< 0.080	< 0.080	<b>0.23</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.23</b>	----	< 0.080	< 0.080	< 0.080	<b>0.37</b>	< 0.080	----	----	<b>0.090</b>	< 0.080	< 5.0	----
SG-TR-11 <sup>[2]</sup>	5	11/21/2005	<b>0.018</b>	<b>0.070</b>	<b>20</b>	<b>0.036</b>	<b>0.75</b>	<b>0.033</b>	< 0.0079	< 0.0035	<b>0.32</b>	----	<b>0.014</b>	< 0.0047	<b>0.085</b>	<b>1.2</b>	<b>0.19</b>	----	----	<b>0.14</b>	<b>0.046</b>	----	< 0.038
SG-TR-11	5	11/18/2005	< 0.080	< 0.080	<b>24</b>	< 0.080	<b>0.89</b>	< 0.080	< 0.080	< 0.080	<b>0.53</b>	----	< 0.080	< 0.080	<b>0.11</b>	<b>1.1</b>	<b>0.15</b>	----	----	<b>0.12</b>	< 0.080	<b>22</b>	----
SG-TR-11	10	11/18/2005	< 0.080	<b>0.11</b>	<b>34</b>	< 0.080	<b>1.2</b>	< 0.080	< 0.080	< 0.080	<b>0.56</b>	----	< 0.080	< 0.080	<b>0.094</b>	<b>1.4</b>	<b>0.33</b>	----	----	<b>0.12</b>	< 0.080	<b>29</b>	----
SG-TR-12	5	11/18/2005	< 0.080	< 0.080	<b>12</b>	< 0.080	<b>0.31</b>	< 0.080	< 0.080	< 0.080	<b>0.57</b>	----	< 0.080	< 0.080	<b>0.16</b>	<b>0.57</b>	<b>0.35</b>	----	----	<b>0.10</b>	< 0.080	<b>14</b>	----
SG-TR-12	10	11/18/2005	< 0.080	< 0.080	<b>16</b>	< 0.080	<b>0.42</b>	< 0.080	< 0.080	< 0.080	<b>0.60</b>	----	< 0.080	< 0.080	< 0.080	<b>0.68</b>	<b>0.62</b>	----	----	< 0.080	< 0.080	<b>16</b>	----
SG-TR-13	5	11/18/2005	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	<b>0.26</b>	< 0.080	< 0.080	----	----	<b>0.15</b>	< 0.080	<b>26*</b>	----
SG-TR-13	10	11/18/2005	< 0.080	< 0.080	<b>0.45</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.14</b>	----	< 0.080	< 0.080	<b>0.14</b>	< 0.080	< 0.080	----	----	<b>0.17</b>	< 0.080	<b>63*</b>	----
SG-028J-3 <sup>[4]</sup> (1 Purge Vol.)	5	3/12/2007	< 0.080	< 0.080	<b>18</b>	< 0.080	<b>0.34</b>	< 0.080	< 0.080	< 0.080	<b>0.40</b>	----	< 0.080	< 0.080	<b>0.27</b>	<b>0.63</b>	<b>0.26</b>	----	----	< 0.20	< 0.080	----	----
SG-028J-3 <sup>[4]</sup> (3 Purge Vol.)	5	3/12/2007	< 0.080	< 0.080	<b>18</b>	< 0.080	<b>0.29</b>	< 0.080	< 0.080	< 0.080	<b>0.31</b>	----	< 0.080	< 0.080	< 0.20	<b>0.59</b>	<b>0.26</b>	----	----	< 0.20	< 0.080	----	----
SG-028J-3 <sup>[4]</sup> (7 Purge Vol.)	5	3/12/2007	< 0.080	< 0.080	<b>19</b>	< 0.080	<b>0.32</b>	< 0.080	< 0.080	< 0.080	<b>0.42</b>	----	< 0.080	< 0.080	<b>0.24</b>	<b>0.66</b>	<b>0.29</b>	----	----	< 0.20	< 0.080	----	----
SG-028J-3	10	3/12/2007	< 0.080	< 0.080	<b>28</b>	< 0.080	<b>0.47</b>	< 0.080	< 0.080	< 0.080	<b>0.61</b>	----	< 0.080	< 0.080	<b>0.25</b>	<b>0.93</b>	<b>0.55</b>	----	----	< 0.20	< 0.080	----	----
SG-028J-4	5	3/12/2007	< 0.080	< 0.080	<b>4.5</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.56</b>	----	< 0.080	< 0.080	<b>0.24</b>	<b>0.18</b>	<b>0.17</b>	----	----	< 0.20	< 0.080	----	----
SG-028J-4 <sup>[3]</sup>	5	3/12/2007	< 0.080	< 0.080	<b>4.3</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.54</b>	----	< 0.080	< 0.080	< 0.20	<b>0.17</b>	<b>0.17</b>	----	----	< 0.20	< 0.080	----	----
SG-028J-4	10	3/12/2007	< 0.080	< 0.080	<b>7.9</b>	< 0.080	<b>0.087</b>	< 0.080	< 0.080	< 0.080	<b>0.69</b>	----	< 0.080	< 0.080	<b>0.30</b>	<b>0.29</b>	<b>0.28</b>	----	----	< 0.20	< 0.080	----	----
SG-028J-5	5	3/12/2007	< 0.080	< 0.080	<b>0.36</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.12</b>	----	< 0.080	< 0.080	<b>0.38</b>	< 0.080	< 0.080	----	----	<b>0.21</b>	< 0.080	----	----
SG-028J-5 <sup>[2]</sup>	10	3/12/2007	<b>0.0095</b>	<b>0.0055</b>	<b>1.4</b>	< 0.0032	< 0.0031	<b>0.063</b>	<b>0.011</b>	<b>0.023</b>	<b>0.19</b>	< 0.0016	< 0.054	<b>0.14</b>	<b>0.19</b>	<b>0.080</b>	<b>0.012</b>	<b>0.15</b>	<b>0.034</b>	<b>0.28</b>	<b>0.11</b>	----	----
SG-028J-5	10	3/12/2007	< 0.080	< 0.080	<b>1.8</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.14</b>	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-6	5	3/12/2007	< 0.080	< 0.080	<b>3.9</b>	< 0.080	<b>0.36</b>	< 0.080	< 0.080	< 0.080	<b>0.26</b>	----	< 0.080	< 0.080	<b>0.34</b>	<b>0.38</b>	< 0.080	----	----	<b>0.20</b>	< 0.080	----	----
SG-028J-6	10	3/12/2007	< 0.080	< 0.080	<b>9.4</b>	< 0.080	<b>0.53</b>	< 0.080	< 0.080	< 0.080	<b>0.40</b>	----	< 0.080	< 0.080	<b>0.36</b>	<b>0.57</b>	< 0.080	----	----	<b>0.21</b>	< 0.080	----	----
SG-028J-7	5	3/12/2007	< 0.080	< 0.080	<b>2.3</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.44</b>	----	< 0.080	< 0.080	<b>0.38</b>	<b>0.22</b>	< 0.080	----	----	<b>0.23</b>	< 0.080	----	----
SG-028J-7	10	3/12/2007	< 0.080	< 0.080	<b>3.1</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.33</b>	----	< 0.080	< 0.080	<b>0.25</b>	<b>0.20</b>	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-8	5	3/13/2007	<b>0.17</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080									

TABLE 2: SUMMARY OF SOIL GAS SAMPLE RESULTS IN THE FORMER BUILDING 028J AREA

Corrective Measures Study Report - Former Building 028J Area

Hitachi Global Storage Technologies, Inc.

5600 Cottle Road, San Jose, California

Location ID	Depth (feet bgs)	Sampling Date	Soil Gas Concentration (ug/L)																		TVH	1,1-DFA	
			Benzene	CT	Chloroform	1,1-DCA	1,1-DCE	Ethyl- benzene	Freon 11	Freon 12	Freon 113	Methyl chloride	Methylene chloride	PCE	Toluene	1,1,1-TCA	TCE	1,2,4- TMB	1,3,5- TMB	m,p-Xylene			o-Xylene
Lowest Residential RBTC - 5 feet bgs <sup>[1]</sup>			0.24	0.18	1.1	4.9	110	3,700	8,900	410	54,000	2.8	6.1	1.4	480	1,800	3.8	11	11	1,300	1,100	110	N/A
Lowest Residential RBTC - 10 feet bgs <sup>[1]</sup>			0.41	0.31	1.9	8.5	190	6,400	16,000	720	93,000	4.7	10	2.4	830	3,100	6.5	19	19	2,200	1,900	390	N/A
SG-028J-14	10	3/13/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-15	5	3/14/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>3.8</b>	<b>0.21</b>	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-15 <sup>[2]</sup>	5	3/14/2007	<b>0.0064</b>	< 0.0045	< 0.0035	< 0.0029	< 0.0029	<b>0.036</b>	<b>0.015</b>	<b>1.6</b>	<b>0.23</b>	< 0.0015	< 0.050	< 0.0049	<b>0.12</b>	<b>0.011</b>	< 0.0039	<b>0.087</b>	<b>0.020</b>	<b>0.16</b>	<b>0.062</b>	----	----
SG-028J-15	10	3/14/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>2.1</b>	<b>0.18</b>	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-16	4	3/14/2007	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.085</b>	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	<b>0.20</b>	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-16	9	3/14/2007	< 0.080	< 0.080	<b>0.094</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-16 <sup>[3]</sup>	9	3/14/2007	< 0.080	< 0.080	<b>0.11</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-17	5	3/14/2007	< 0.080	< 0.080	<b>1.6</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.41</b>	----	< 0.080	< 0.080	< 0.20	< 0.080	<b>0.090</b>	----	----	< 0.20	< 0.080	----	----
SG-028J-17	10	3/14/2007	< 0.080	< 0.080	<b>2.7</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.35</b>	----	< 0.080	< 0.080	< 0.20	<b>0.11</b>	<b>0.11</b>	----	----	< 0.20	< 0.080	----	----
SG-028J-18	3	3/14/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-18	8	3/14/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	<b>0.34</b>	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-19	3	3/14/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-19	10	3/14/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-20	3	3/14/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.15</b>	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-20	10	3/14/2007	< 0.080	< 0.080	<b>0.92</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.24</b>	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-21	5	3/14/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-21	10	3/14/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-22	4	3/15/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-22	8	3/15/2007	<b>0.11</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	<b>0.74</b>	< 0.080	< 0.080	----	----	<b>0.21</b>	< 0.080	----	----
SG-028J-23	4	3/15/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.38</b>	< 0.080	< 0.080	----	<b>0.14</b>	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-23 <sup>[2]</sup>	10	3/15/2007	<b>0.0098</b>	< 0.0044	<b>0.28</b>	< 0.0028	< 0.0028	<b>0.053</b>	<b>0.025</b>	<b>0.0055</b>	<b>0.11</b>	< 0.0014	< 0.049	<b>0.024</b>	<b>0.16</b>	<b>0.0085</b>	< 0.0038	<b>0.13</b>	<b>0.031</b>	<b>0.25</b>	<b>0.092</b>	----	----
SG-028J-23	10	3/15/2007	< 0.080	< 0.080	<b>0.28</b>	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.099</b>	----	< 0.080	< 0.080	<b>0.28</b>	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-24	5	3/15/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	<b>0.092</b>	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-24	10	3/15/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-25	5	3/15/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-25	10	3/15/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----
SG-028J-25 <sup>[3]</sup>	10	3/15/2007	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080	----	< 0.080	< 0.080	< 0.20	< 0.080	< 0.080	----	----	< 0.20	< 0.080	----	----

Notes:

Only compounds detected in at least one sample are shown. Results are in micrograms per liter (ug/L).

Samples analyzed by USEPA Method 8260B using mobile laboratory unless indicated otherwise.

[1] Lowest Risk-Based Target Concentrations (RBTCs) for residential land use as presented in the Final Remedy Completion Report for the Redevelopment Property (*Source: Final Remedy Completion Report, Redevelopment Property, Hitachi Global Storage Technologies, Inc., 5600 Cottle Road, San Jose, California. Prepared by ENVIRON, August, 2007* ).

[2] Sample analyzed at fixed-base laboratory by USEPA Method TO-14.

[3] Duplicate sample.

[4] Purge volume test with 1, 3, and 7 purge volumes performed at this location.

bgs = below ground surface

---- = not analyzed

\* = TVH result from uncharacteristic peak

< = the analyte was not detected above the detection limit

Results detected above the reporting limit are shown in **bold**. Shaded values indicate the constituent was detected above its RBTC.

"CT" = Carbon Tetrachloride

"1,1-DCA" = 1,1-Dichloroethane

"1,1-DCE" = 1,1-Dichloroethene

"PCE" = Tetrachloroethene

"1,1,1-TCA" = 1,1,1-Trichloethane

"TCE" = Trichloroethene

"1,2,4-TMB" = 1,2,4-Trimethylbenzene

"1,3,5-TMB" = 1,3,5-Trimethylbenzene

"TVH" = Total Volatile Hydrocarbons

"1,1-DFA" = 1,1-Difluoroethane (leak check compound)

**TABLE 3: SUMMARY OF SOIL SAMPLING RESULTS IN THE FORMER BUILDING 028J AREA**  
**Corrective Measures Study Report - Former Building 028J Area**  
**Hitachi Global Storage Technologies, Inc.**  
**5600 Cottle Road, San Jose, California**

Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Chloroform (ug/kg)	1,1,2 - Trichloroethane (ug/kg)
<i>Lowest Residential Risk-Based Target Concentration (RBTC) <sup>[1]</sup></i>				8.7	7.9
28J-1	28J-1-0-0.5'	0.0	9/5/2006	<4.9	<4.9
	28J-1-4.5-5'	5.0	9/5/2006	<5.0	<5.0
	28J-1-9.5-10'	10.0	9/5/2006	<4.9	<4.9
	28J-1-15-15.5'	15.0	9/5/2006	<4.9	<4.9
	28J-1-19.5-20'	20.0	9/5/2006	<4.9	<4.9
28J-2	28J-2-0-0.5'	0.0	9/5/2006	<5.0	<5.0
	28J-2-4.5-5'	5.0	9/5/2006	<4.8	<4.8
	28J-2-10-10.5	10.0	9/5/2006	<4.9	<4.9
	28J-2-15-15.5'	15.0	9/5/2006	<5.0	<5.0
	28J-2-19.5-20'	20.0	9/5/2006	<4.9	<4.9
28J-3	28J-3-0-0.5'	0.0	9/5/2006	<5.0	<5.0
	28J-3-4.5-5'	5.0	9/5/2006	<4.8	<4.8
	28J-3-9.5-10'	10.0	9/5/2006	<4.9	<4.9
	28J-3-14.5-15'	15.0	9/5/2006	<5.0	<5.0
	28J-3-19.5-20'	20.0	9/5/2006	14	<5.0
28J-4	28J-4-0-0.5'	0.0	9/5/2006	<4.9	<4.9
	28J-4-4.5-5'	5.0	9/5/2006	8.5	<4.8
	28J-4-10.5-11'	11.0	9/5/2006	14	<5.0
	28J-4-15.5-16'	16.0	9/5/2006	17	<5.0
	28J-4-19.5-20'	20.0	9/5/2006	15	<4.9
28J-5	28J-5-0-0.5'	0.0	9/5/2006	<4.9	<4.9
	28J-5-4.5-5'	5.0	9/5/2006	<5.0	<5.0
	28J-5-9.5-10'	10.0	9/5/2006	<5.0	<5.0
	28J-5-15-15.5'	16.0	9/5/2006	5.7	<5.0
	28J-5-19.5-20'	20.0	9/5/2006	<4.9	<4.9
28J-6	28J-6-0-0.5'	0.0	9/5/2006	<4.9	<4.9
	28J-6-4.5-5'	5.0	9/5/2006	<5.0	<5.0
	28J-6-9.5-10'	10.0	9/5/2006	<5.0	<5.0
	28J-6-15-15.5'	15.0	9/5/2006	<5.0	<5.0
	28J-6-19.5-20'	20.0	9/5/2006	<4.9	<4.9
28J-7	28J-7-0-0.5'	0.0	9/5/2006	<4.9	<4.9
	28J-7-4.5-5'	5.0	9/5/2006	<4.8	<4.8
	28J-7-10-10.5'	10.0	9/5/2006	<5.0	<5.0
	28J-7-15-15.5'	15.0	9/5/2006	7.2	<4.8
	28J-7-19.5-20'	20.0	9/5/2006	10	<5.0
28J-8	28J-8-0-0.5'	0.0	9/5/2006	<4.9	<4.9
	28J-8-4.5-5'	5.0	9/5/2006	<5.0	<5.0
	28J-8-10-10.5	10.0	9/5/2006	<4.8	<4.8
	28J-8-15-15.5'	15.0	9/5/2006	8.7	<4.8
	28J-8-19.5-20'	20.0	9/5/2006	10	<4.9

**TABLE 3: SUMMARY OF SOIL SAMPLING RESULTS IN THE FORMER BUILDING 028J AREA**  
**Corrective Measures Study Report - Former Building 028J Area**  
**Hitachi Global Storage Technologies, Inc.**  
**5600 Cottle Road, San Jose, California**

Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Chloroform (ug/kg)	1,1,2 - Trichloroethane (ug/kg)
<i>Lowest Residential Risk-Based Target Concentration (RBTC) <sup>(1)</sup></i>				8.7	7.9
28J-A	28J-A-5	5.0	12/7/2006	5.0	4.4
	28J-A-10	10.0	12/7/2006	<4.8	<4.8
	28J-A-15	15.0	12/7/2006	13	<4.7
	28J-A-20	20.0	12/7/2006	21	<4.2
28J-B	28J-B-5	5.0	12/7/2006	5.8	<3.8
	28J-B-10	10.0	12/7/2006	5.3	<3.9
	28J-B-15	15.0	12/7/2006	18	<4.9
	28J-B-20	20.0	12/7/2006	21	<3.9
28J-C	28J-C-5	5.0	12/7/2006	18	<3.9
	28J-C-10	10.0	12/7/2006	<5.0	<5.0
	28J-C-15	15.0	12/7/2006	16	<4.2
	28J-C-20	20.0	12/7/2006	22	<4.1
28J-D	28J-D-5	5.0	12/7/2006	6.7	<3.8
	28J-D-10	10.0	12/7/2006	<4.5	<4.5
	28J-D-15	15.0	12/7/2006	21	<4.8
	28J-D-20	20.0	12/7/2006	16	<4.0
28J-E	28J-E-5	5.0	12/7/2006	5.3	<3.7
	28J-E-10	10.0	12/7/2006	6.1	<5.5
	28J-E-15	15.0	12/7/2006	21	<4.3
	28J-E-20	20.0	12/7/2006	31	<4.3
28J-F	28J-F-5	5.0	12/7/2006	<5.4	<5.4
	28J-F-10	10.0	12/7/2006	<8.2	<8.2
	28J-F-15	15.0	12/7/2006	16	<4.2
	28J-F-20	20.0	12/7/2006	10	<4.0
28J-G	28J-G-5	5.0	12/7/2006	5	<3.8
	28J-G-10	10.0	12/7/2006	<7.8	<7.8
	28J-G-15	15.0	12/7/2006	20	<4.1
	28J-G-20	20.0	12/7/2006	27	<4.2
28J-H	28J-H-5	5.0	12/7/2006	<4.2	<4.2
	28J-H-10	10.0	12/7/2006	<4.8	<4.8
	28J-H-15	15.0	12/7/2006	9.2	<4.1
	28J-H-20	20.0	12/7/2006	15	<4.2
28J-I	28J-I-5	5.0	12/7/2006	<3.8	<3.8
	28J-I-10	10.0	12/7/2006	<5.9	<5.9
	28J-I-15	15.0	12/7/2006	<4.0	<4.0
	28J-I-20	20.0	12/7/2006	<4.3	<4.3
28J-J	28J-J-5	5.0	12/7/2006	<4.0	<4.0
	28J-J-10	10.0	12/7/2006	<4.4	<4.4
	28J-J-15	15.0	12/7/2006	7.6	<4.1
	28J-J-20	20.0	12/7/2006	9.7	<4.2



**TABLE 3: SUMMARY OF SOIL SAMPLING RESULTS IN THE FORMER BUILDING 028J AREA**  
**Corrective Measures Study Report - Former Building 028J Area**  
**Hitachi Global Storage Technologies, Inc.**  
**5600 Cottle Road, San Jose, California**

Boring ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Chloroform (ug/kg)	1,1,2 - Trichloroethane (ug/kg)
<i>Lowest Residential Risk-Based Target Concentration (RBTC) <sup>[1]</sup></i>				8.7	7.9
028J-K	028J-K-5'	5.0	1/24/2007	<4.4	<4.4
	028J-K-10'	10.0	1/24/2007	<4.9	<4.9
	028J-K-15'	15.0	1/24/2007	<b>6</b>	<4.1
	028J-K-20'	20.0	1/24/2007	<b>7.1</b>	<4.3
028J-L	028J-L-5'	5.0	1/24/2007	<b>5.9</b>	<4.1
	028J-L-10'	10.0	1/24/2007	<4.2	<4.2
	028J-L-15'	15.0	1/24/2007	<b>9.3</b>	<4.1
	028J-L-20'	20.0	1/24/2007	<b>11</b>	<4.0
028J-M	028J-M-5'	5.0	1/24/2007	<b>6</b>	<4.2
	028J-M-10'	10.0	1/24/2007	<4.4	<4.4
	028J-M-15'	15.0	1/24/2007	<b>5.9</b>	<4.0
	028J-M-20'	20.0	1/24/2007	<b>9.1</b>	<4.1
028J-N	028J-N-5'	5.0	1/24/2007	<4.4	<4.4
	028J-N-10'	10.0	1/24/2007	<4.8	<4.8
	028J-N-15'	15.0	1/24/2007	<4.0	<4.0
	028J-N-20'	20.0	1/24/2007	<4.1	<4.1
028J-O	028J-O-5'	5.0	1/24/2007	<4.7	<4.7
	028J-O-10'	10.0	1/24/2007	<4.5	<4.5
	028J-O-15'	15.0	1/24/2007	<4.1	<4.1
	028J-O-20'	20.0	1/24/2007	<4.1	<4.1
	028J-O-25'	25.0	1/24/2007	<4.3	<4.3
028J-P	028J-P-5'	5.0	1/24/2007	<4.0	<4.0
	028J-P-10'	10.0	1/24/2007	<4.2	<4.2
	028J-P-15'	15.0	1/24/2007	<4.4	<4.4
	028J-P-20'	20.0	1/24/2007	<4.1	<4.1

**Notes:**

Only compounds detected in at least one sample are shown. Results are in micrograms per kilogram (ug/kg).

Samples analyzed by USEPA Method 8260B by Severn Trent Laboratories, Inc., (STL) of San Francisco, California.

[1] Lowest Risk-Based Target Concentrations (RBTCs) for residential land use as presented in the Final Remedy Completion Report for the Redevelopment Property (Source: *Final Remedy Completion Report, Redevelopment Property, Hitachi Global Storage Technologies, Inc., 5600 Cottle Road, San Jose, California. Prepared by ENVIRON, August, 2007* ).

bgs = below ground surface.

< = the analyte was not detected above the detection limit.

Results detected above the reporting limit are shown in **bold**. Shaded values indicate the constituent was detected above its RBTC.

**TABLE 4: GRAB GROUNDWATER RESULTS IN THE FORMER BUILDING 028J AREA**  
**Corrective Measures Study Report - Former Building 028J Area**  
**Hitachi Global Storage Technologies, Inc.**  
**5600 Cottle Road, San Jose, California**

Location ID	Sample Depth (feet bgs)	Sample Date	Chloroform (ug/L)	1,1-DCA (ug/L)	1,1-DCE (ug/L)	Toluene (ug/L)	1,1,1-TCA (ug/L)	TCE (ug/L)	Xylenes, Total (ug/L)
<i>Lowest Residential RBTC <sup>[1]</sup></i>			380	1,200	30,000	160,000	520,000	1,100	390,000
<i>RWQCB-SF Cleanup Standard <sup>[2]</sup></i>			80	5	6	----	200	5	1,750
GW-28J-C	32	1/25/2007	<b>170</b>	<2.0	<b>4.6</b>	<2.0	<b>8.6</b>	<2.0	< 4.0
GW-28J-F	33	1/25/2007	<b>320</b>	<5.0	<5.0	<5.0	<5.0	<5.0	< 10
GW-28J-O	27	1/24/2007	<b>3.5</b>	<0.50	< 0.50	<b>0.76</b>	< 0.50	<0.50	< 1.0
GW-SG-028J-1	28	1/24/2007	<b>1.8</b>	<0.50	< 0.50	<b>0.96</b>	<b>1.1</b>	<0.50	<b>1.3</b>
GW-028J-Q	29	2/28/2007	<2.0	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0
GW-028J-R	29	2/28/2007	<2.0	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0
GW-028J-S	30	2/28/2007	<b>8.0</b>	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0
GW-028J-T	33	2/28/2007	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0
GW-028J-U	27	2/28/2007	<b>890</b>	<10	<10	<10	<10	<10	<20
GW-028J-V	26	3/1/2007	<b>170</b>	<2.0	<2.0	<2.0	<2.0	<2.0	<4.0
GW-028J-W	30	3/1/2007	<b>170</b>	<2.0	<2.0	<2.0	<2.0	<2.0	<4.0
GW-028J-X	24	3/1/2007	<b>73</b>	<0.50	<b>1.8</b>	<0.50	<b>1.5</b>	<0.50	<1.0
GW-028J-Y	26	3/1/2007	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0
GW-028J-Z	24	3/1/2007	<b>1.8</b>	<0.50	<0.50	<0.50	<b>0.5</b>	<0.50	<1.0
GW-028J-1	27	3/13/2007	<4.0	<2.0	<2.0	<2.0	<2.0	<2.0	<4.0
GW-028J-2	26	3/13/2007	<4.0	<2.0	<2.0	<2.0	<2.0	<2.0	<4.0
GW-028J-3	26	3/13/2007	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0
GW-028J-4	27	3/13/2007	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0
GW-028J-5	24	3/12/2007	<2.0	<1.0	<1.0	<1.0	<1.0	<1.0	<2.0
GW-028J-6	26	3/12/2007	<1.0	<0.50	<0.50	<0.50	<b>0.54</b>	<0.50	<1.0
GW-028J-7	25	3/12/2007	<b>28</b>	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0
GW-028J-8	28	3/13/2007	<b>810</b>	<b>0.64</b>	<b>2.9</b>	<0.50	<b>6.3</b>	<b>7.5</b>	<1.0
GW-028J-9	27	3/13/2007	<b>160</b>	<1.0	<b>1.3</b>	<1.0	<b>1.9</b>	<1.0	<2.0
GW-028J-10	27	3/13/2007	<b>130</b>	<1.0	<1.0	<1.0	<b>2.7</b>	<1.0	<2.0
GW-028J-12	26	3/12/2007	<b>9.2</b>	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0
GW-028J-13	29	3/13/2007	<b>120</b>	<1.0	<1.0	<1.0	<b>1.6</b>	<1.0	<2.0
GW-028J-15	29	3/12/2007	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	<1.0
GW-028J-16	30	3/12/2007	<1.0	<0.50	<0.50	<2.0	<0.50	<0.50	<1.0

**Notes:**

Only compounds detected in at least one sample are shown. Results are in micrograms per liter (ug/L).

Samples analyzed by USEPA Method 8260B by Severn Trent Laboratories, Inc., (STL) of San Francisco, California.

[1] Lowest Risk-Based Target Concentrations (RBTCs) for residential land use as presented in the Final Remedy Completion Report for the Redevelopment Property (Source: *Final Remedy Completion Report, Redevelopment Property, Hitachi Global Storage Technologies, Inc., 5600 Cottle Road, San Jose, California. Prepared by ENVIRON, August, 2007* ).

[2] Regional Water Quality Control Board - San Francisco Bay Region (RWQCB-SF) groundwater Cleanup Standard for the A-aquifer (Source: *RWQCB-SF Order No. R2-2002-0082 - Final Site Cleanup Requirements, International Business Machines, Inc., 5600 Cottle Road, San Jose, California, as amended by Order NO. R2-2007-004* ).

bgs = below ground surface.

< = the analyte was not detected above the detection limit.

---- = not available

"1,1-DCA" = 1,1-Dichloroethane

"1,1,1-TCA" = 1,1,1-Trichloroethane

"1,1-DCE" = 1,1-Dichloroethene

"TCE" = Trichloroethene

Results detected above the reporting limit are shown in **bold**. Shaded values indicate the constituent was detected above its RBTC.

**TABLE 5: GRAB GROUNDWATER RESULTS IN THE B-AQUIFER - APRIL 2007****Corrective Measures Study Report - Former Building 028J Area****Hitachi Global Storage Technologies, Inc.****5600 Cottle Road, San Jose, California**

Location ID	Sample ID	Sample Depth (feet bgs)	Sample Date	Chloroform (ug/L)	1,1,1-Trichloroethane (ug/L)	Freon 113 (ug/L)
<i>Lowest Residential Risk-Based Target Concentration (RBTC) <sup>[1]</sup></i>				380	520,000	9,200,000
<i>RWQCB-SF Groundwater Cleanup Standard for B-Aquifer <sup>[2]</sup></i>				----	40	120
CPT-1	CPT-1-44-46	44-46	4/19/2007	<b>3.8</b>	<0.50	<b>0.81</b>
CPT-1	CPT-1-TB <sup>[3]</sup>	na	4/19/2007	<1.0	<0.50	<0.50
CPT-2	CPT-2-44-46	44-46	4/19/2007	<1.0	<0.50	<b>0.82</b>
CPT-5	CPT-5-44-46	44-46	4/20/2007	<b>34</b>	<b>0.55</b>	<b>0.57</b>
CPT-6	CPT-6-47-49	47-49	4/19/2007	<1.0	<0.50	<b>0.62</b>
CPT-6	CPT-6-DUP <sup>[4]</sup>	47-49	4/19/2007	<1.0	<0.50	<b>0.54</b>
CPT-6	CPT-6-EB <sup>[5]</sup>	na	4/19/2007	<1.0	<0.50	<0.50
CPT-8	CPT-8-47-49	47-49	4/19/2007	<1.0	<0.50	<b>0.53</b>

Notes:

Only compounds detected in at least one sample are shown. Results are in micrograms per liter (ug/L).

Samples analyzed by USEPA Method 8260B by Severn Trent Laboratories, Inc., (STL) of San Francisco, California.

[1] Lowest Risk-Based Target Concentrations (RBTCs) for residential land use as presented in the Final Remedy Completion Report for the Redevelopment Property (Source: *Final Remedy Completion Report, Redevelopment Property, Hitachi Global Storage Technologies, Inc., 5600 Cottle Road, San Jose, California. Prepared by ENVIRON, August, 2007* ).

[2] Regional Water Quality Control Board - San Francisco Bay Region (RWQCB-SF) groundwater Cleanup Standard for the B-aquifer (Source: *RWQCB-SF Order No. R2-2002-0082 - Final Site Cleanup Requirements, International Business Machines, Inc., 5600 Cottle Road, San Jose, California, as amended by Order NO. R2-2007-004* ).

[3] Trip Blank

[4] Duplicate

[5] Equipment Blank

bgs = below ground surface.

< = the analyte was not detected above the detection limit.

na = not applicable

---- = not available

Results detected above the reporting limit are shown in **bold**. Shaded values indicate the constituent was detected above its RBTC.

**TABLE 6: GROUNDWATER WELL CONSTRUCTION DETAILS**  
**Corrective Measures Study Report - Former Building 028J Area**  
**Hitachi Global Storage Technologies, Inc.**  
**5600 Cottle Road, San Jose, California**

Well	Installation Date	Survey Point <sup>[1]</sup> (feet amsl)	Groundwater Elevation (feet amsl) <sup>[2]</sup>	Total Depth (feet bgs)	Casing Material	Casing Diameter	Screen Slot Size	Screened Interval (feet bgs)	Filter Pack Interval (feet bgs)
EW-1	4/26/2007	191.30	161.82	37.5	PVC	4"	0.020"	17.0 - 37.0	15.0 - 37.5
EW-2	4/24/2007	189.62	161.85	37.5	PVC	4"	0.020"	17.0 - 37.0	15.0 - 37.5
EW-3	4/27/2007	190.17	162.01	36.5	PVC	4"	0.020"	16.0 - 36.0	14.0 - 36.5
EW-4	4/24/2007	192.34	161.80	37.5	PVC	4"	0.020"	17.0 - 37.0	15.0 - 37.5
EW-5	4/27/2007	191.19	161.81	37.0	PVC	4"	0.020"	16.5 - 36.5	14.5 - 37.0
EW-6	4/25/2007	190.51	161.86	37.5	PVC	4"	0.020"	17.0 - 37.0	15.0 - 37.5
EW-7	4/30/2007	190.88	162.12	36.5	PVC	4"	0.020"	16.0 - 36.0	14.0 - 36.5
EW-8	4/26/2007	193.19	161.77	37.5	PVC	4"	0.020"	17.0 - 37.0	15.0 - 37.5
EW-9	5/1/2007	192.63	161.78	38.0	PVC	4"	0.020"	17.5 - 37.5	15.5 - 38.0
EW-10	4/26/2007	192.75	161.79	38.5	PVC	4"	0.020"	18.0 - 38.0	16.0 - 38.5
EW-11	4/30/2007	192.78	161.86	37.5	PVC	4"	0.020"	17.0 - 37.0	15.0 - 37.5
EW-12	4/23/2007	191.90	161.94	38.5	PVC	4"	0.020"	18.0 - 38.0	16.0 - 38.5
EW-13	5/1/2007	194.19	161.73	38.5	PVC	4"	0.020"	18.0 - 38.0	16.0 - 38.5
EW-14	4/30/2007	193.71	161.80	38.5	PVC	4"	0.020"	18.0 - 38.0	16.0 - 38.5
EW-15	4/25/2007	193.29	161.76	38.5	PVC	4"	0.020"	18.0 - 38.0	16.0 - 38.5

Notes:

[1] Survey of monitoring wells was performed by Ruggeri-Jensen-Azar (RJA) of Pleasanton, California on May 7, 2007.

[2] Measured in May 2007 prior to 2-PHASE™ Extraction pilot test.

amsl = above mean sea level

bgs = below ground surface

**TABLE 7: GROUNDWATER WELL SAMPLE RESULTS - MAY 2007****Corrective Measures Study Report - Former Building 028J Area****Hitachi Global Storage Technologies, Inc.****5600 Cottle Road, San Jose, California**

Location ID	Sample ID	Sample Date	Chloroform (ug/L)	1,1-Dichloroethane (ug/L)	1,1-Dichloroethene (ug/L)	1,1,1-Trichloroethane (ug/L)
<i>Lowest Residential Risk-Based Target Concentration (RBTC) <sup>[1]</sup></i>			380	1,200	30,000	520,000
<i>RWQCB-SF Groundwater Cleanup Standard for the A-Aquifer <sup>[2]</sup></i>			80	5	6	200
EW-1	EW-1-08052007	5/8/2007	<b>49</b>	<b>0.6</b>	<b>4.1</b>	<b>11</b>
EW-2	EW-2-08052007	5/8/2007	<b>95</b>	<0.5	<b>3.7</b>	<b>5.4</b>
EW-3	EW-3-07052007	5/7/2007	<b>2.0</b>	<0.5	<0.5	<0.5
EW-3	EW-3-TB <sup>[3]</sup>	5/7/2007	<1	<0.5	<0.5	<0.5
EW-4	EW-4-08052007	5/8/2007	<b>520</b>	<5	<5	<b>12</b>
EW-5	EW-5-09052007	5/9/2007	<b>870</b>	<10	<10	<10
EW-6	EW-6-08052007	5/8/2007	<b>130</b>	<1	<b>2.7</b>	<b>3.1</b>
EW-7	EW-7-07052007	5/7/2007	<b>5.9</b>	<0.5	<b>1.2</b>	<b>0.9</b>
EW-8	EW-8-08052007	5/8/2007	<b>12</b>	<0.5	<0.5	<b>1.4</b>
EW-8	EW-8-DUP <sup>[4]</sup>	5/8/2007	<b>12</b>	<0.5	<0.5	<b>1.4</b>
EW-8	EW-8-EB <sup>[3]</sup>	5/8/2007	<1	<0.5	<0.5	<0.5
EW-9	EW-9-09052007	5/9/2007	<b>920</b>	<10	<10	<10
EW-10	EW-10-09052007	5/9/2007	<b>550</b>	<5	<5	<5
EW-11	EW-11-08052007	5/8/2007	<b>56</b>	<0.5	<b>1.2</b>	<b>4.4</b>
EW-12	EW-12-07052007	5/7/2007	<b>10</b>	<0.5	<0.5	<b>1.7</b>
EW-13	EW-13-09052007	5/9/2007	<b>350</b>	<5	<5	<5
EW-14	EW-14-09052007	5/9/2007	<b>150</b>	<1	<1	<b>3.3</b>
EW-15	EW-15-08052007	5/8/2007	<b>3.5</b>	<0.5	<0.5	<b>1.7</b>

Notes:

Only compounds detected in at least one sample are shown. Results are in micrograms per liter (ug/L).

Samples analyzed by USEPA Method 8260B by Severn Trent Laboratories, Inc., (STL) of San Francisco, California.

[1] Lowest Risk-Based Target Concentrations (RBTCs) for residential land use as presented in the Final Remedy Completion Report for the Redevelopment Property (Source: *Final Remedy Completion Report, Redevelopment Property, Hitachi Global Storage Technologies, Inc., 5600 Cottle Road, San Jose, California. Prepared by ENVIRON, August, 2007* ).[2] Regional Water Quality Control Board - San Francisco Bay Region (RWQCB-SF) groundwater Cleanup Standard for the A-aquifer (Source: *RWQCB-SF Order No. R2-2002-0082 - Final Site Cleanup Requirements, International Business Machines, Inc., 5600 Cottle Road, San Jose, California, as amended by Order NO. R2-2007-004* ).

[3] Trip Blank

[4] Duplicate

[5] Equipment Blank

&lt; = the analyte was not detected above the detection limit.

Results detected above the reporting limit are shown in **bold**. Shaded values indicate the constituent was detected above its RBTC.

TABLE 8: SCREENING OF TECHNOLOGIES FOR REMEDIATION OF THE FORMER BUILDING 028J AREA  
Corrective Measures Study Report - Former Building 028J Area  
Hitachi Global Storage Technologies, Inc.  
5600 Cottle Road, San Jose, California

Remedial Option	Process Description	Cleanup Time	Effectiveness	Potential Limitations	Capital/O&M Cost	Screening Result
Removal Technologies						
Soil Vapor Extraction (SVE)	Use vacuum blower to extract soil vapor from wells screened in the vadose zone.	Short to Moderate	Well demonstrated and widely used. SVE can be thermally-enhanced if necessary.	Significantly higher costs if thermal enhancements are employed. Aquifers with high flow rates can significantly reduce performance. A pilot test is required to determine feasibility.	Moderate / Moderate	Retained as an option for concurrent soil and groundwater remediation.
2-PHASE™ Extraction	Use vacuum blower to extract groundwater and soil vapor from conventional groundwater wells. Similar to a SVE, but it also dewateres the formation to increase mass transfer to the vapor phase.	Short to Moderate	Well demonstrated and widely used.	A pilot test is required to determine feasibility.	Moderate / Moderate	Retained as an option for concurrent soil and groundwater remediation.
Groundwater Extraction (Pump & Treat)	Extract groundwater from wells using submersible pumps.	Moderate	Well demonstrated and widely used. Can be effective in hydraulic containment of contaminants.	Vadose zone contamination is not addressed. Low flow conditions limit effectiveness.	Low / Moderate	Rejected because low flow conditions limit effectiveness and because vadose zone contamination is not addressed.
Air Sparging	Use forced air flow to transfer volatile contaminants from the aqueous phase to the gaseous phase.	Moderate	Well demonstrated and widely used. Performance better with contaminants with lower solubility and soils with higher permeability.	Potential for inducing migration of contaminants. A pilot test is required to determine feasibility.	Low / Moderate	Rejected due to potential for inducing migration of chloroform.
Aboveground Treatment Technologies						
Carbon Adsorption	Use carbon adsorbents to remove VOCs from contaminated groundwater and vapor.	N/A	Well-demonstrated and widely used. Removes VOCs readily from water and vapor, but efficiencies vary with the compound.	Regular carbon disposal or regeneration. Bench and/or pilot test with specific waste streams typically recommended.	Low / Low	Retained as alternative for aboveground treatment.
Chemical/UV Oxidation	Use chemical, photo (UV), or other oxidation reactions to destroy contaminants in groundwater.	N/A	Widely used for water treatment.	Can be complicated to implement. Extra components to maintain. High capital and O&M cost. Marginal effectiveness with chloroform and limited effectiveness for vapor streams.	High / High	Rejected due to complexity of operation and need for separate vapor treatment process.
Thermal Oxidation	Use high heat to destroy VOCs in vapor.	N/A	Widely used for vapor treatment of VOCs.	Potential catalyst fouling. High capital and O&M cost. More effective with higher influent concentrations.	High / High	Rejected due to its high cost and marginal effectiveness with low influent concentrations.

TABLE 8: SCREENING OF TECHNOLOGIES FOR REMEDIATION OF THE FORMER BUILDING 028J AREA

Corrective Measures Study Report - Former Building 028J Area

Hitachi Global Storage Technologies, Inc.

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Remedial Option	Process Description	Cleanup Time	Effectiveness	Potential Limitations	Capital/O&M Cost	Screening Result
<i>In-Situ Technologies</i>						
Bioremediation Via In-Situ Gaseous Substrate Injection	Use forced air flow containing substrates to degrade chloroform.	Moderate to Long	Methanotrophes and/or propane using bacteria may cometabolically degrade chloroform. Bench-scale and/or pilot-scale tests are required.	Suffers the same limitations as air sparging. Indigenous microorganisms may not exist at the Site. Elevated chloroform concentrations inhibit microorgansims and cause low removal rates.	Moderate / Moderate	Rejected due to problems with elevated chloroform concentrations and the potential for gaseous substrate injection to induce chloroform migration.
In-Situ Anaerobic Bioremediation	Utilize organic substrates to produce a biological reaction zone in which chlororform is degraded by microorganisms. There are various substrate delivery modes, including direct injection, substrate recirculation, and in-situ precipitation.	Moderate to Long	Anaerobic co-metabolic processes can potentially degrade chloroform. Reaction rates can be very slow. Bench-scale and/or pilot-scale tests are required.	Different remedial approach is needed for soil contamination. Indigenous microorganisms may not exist at the Site. Elevated chloroform concentrations inhibit microorgansims and cause low removal rates.	Low to Moderate / Low to Moderate	Rejected due to problems with elevated chloroform concentrations.
In-Situ Chemical Oxidation	Inject oxidants to oxidize chloroform. Typically oxidants include ozone, hydrogen peroxide, sodium / potassium permanganate, and sodium persulfate.	Relatively short	Limited effectiveness with chloroform.	May result in other deleterious water quality issues (Cr6+). Suffers the same limitations as air sparging when ozone is used. High doses of oxidants may be required. Difficult to distribute oxidants in subsurface.	Moderate to High / Moderate to High	Rejected because chloroform is not easily degraded using this approach.
In-Situ Chemical Reduction Via Zero Valent Iron (ZVI)	Apply ZVI by pnumatic slurry injection to degrade chloroform.	Relatively short	Demonstrated effective for PCE and TCE. Reaction rates significantly slower with chloroform. Effectiveness depends on ability to distribute ZVI in subsurface. Not effective in vadose zone.	Different remedial approach is needed for soil contamination. Potentially slow reaction rates. High doses of ZVI may be required. Difficult to distribute ZVI in subsurface.	Moderate to High / Moderate to High	Rejected because of potential slow reaction rates with chloroform and requiremment for a separate remedial approach for the vadose zone.